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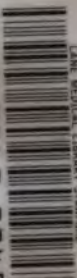
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HANDBOOK OF ELECTROTHERAPY

FOR PRACTITIONERS AND
STUDENTS

BY

BURTON BAKER GROVER, M.D.

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*ILLUSTRATED WITH 103 ENGRAVINGS IN THE
TEXT AND 6 PLATES OF 12 CHARTS*



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TO MY WIFE.

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FOREWORD.

ABOUT twenty-five thousand physicians in the United States employ electricity as a therapeutic agent, many of whom have in their possession some form of electrical apparatus.

Owing to the fact that few medical colleges include electrotherapeutics in their curriculum, little opportunity is given medical men to become familiar with modern methods of its application, and many fail to secure favorable results because proper instruction is not available.

This work is intended to give practical instruction covering the indications and use of the various currents in practice; the subjects treated, in the main, are briefly considered, but up to date. An effort has been made to boil down the subject of electrotherapy and to treat it in a manner that it may be understood and made useful not only to every electrotherapist but to the entire medical profession.

Electricity has no magic formulas, but is an efficient helpmate in the practice of medicine.

The bibliography at the close of the book is not complete. It is impossible to render full acknowledgment to all sources which have assisted me in preparing this work. However, I am indebted to many writers whose articles have appeared from time to time during the past ten years in the American Journal of Electrotherapeutics and Radiology.

I fully realize that the subject of electrotherapeutics has not been fully elucidated, but an effort has been made to point out the essentials that they may be of assistance to those who employ electricity as a therapeutic agent in medicine.

BURTON B. GROVER.

COLORADO SPRINGS,
COLORADO.

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CHAPTER I.

FUNDAMENTAL PRINCIPLES OF ELECTRICITY.

What is electricity? A little history. Radioactivity. Classification of electricity. Energy. Volts. Amperes. Ohms. Watts. Chemical and thermal electricity. Polarity. Electricity not a cure-all.

It may be conjectured that in the beginning God said let there be an electron and there was an electron.

An electron is the basis of all fundamental matter. Every electron is the same as every other electron, the difference in matter, as it appears to us, being due to the number and movement of the electrons in relation one to another within the atom of that particular substance. An electron consists of an electrical charge. It is possible to count electrons as they emanate from radium as helium. It is quite probable that helium was the first existing element from which all other matter is transmuted, and as all matter is more or less radioactive or constantly returning to helium, we may presume that from helium we came and unto helium shall return.

WHAT IS ELECTRICITY?

Electricity is defined by Gould as one of the forces of nature developed or generated by chemism, magnetism, or friction, and probably a mode of etherial vibration, closely analogous to and convertible into heat and light; by another, as the source of energy; by another, as a pent-up energy set free by chemical and mechanical effects. A prominent teacher of electrotherapeutics says: "While we do not know *what* it is, we do know what it is *not*. It

is not a tangible entity. It is not energy, as many claim. Electricity is a condition."

The theory accepted by most physicists of today is that electricity is a *substance*, composed of moving electrons, and is made manifest to us by its magnetic, thermal, and chemical effects.

An atom of hydrogen, the lightest conceivable particle of gas known to us today, is said to contain approximately 1800 electrons. The metal iron and hydrogen gas differ only in the number of electrons and the manner in which they are grouped. The x-ray is the agent through which the testimony of the proof of this statement has been collected.

An electrical charge possesses inertia, so it is legitimate to say that a current of electricity consists of definite particles of material.

An electron can shoot across space or through substances such as iron, copper, glass, etc., without touching the electrons of the substance through which it passes. Electrons flow through metals as does water through a pipe. Pictures of electrons passing through air have been taken.

The nucleus of the atom of any substance is composed of positive electrons and approximates one-half its atomic weight and about $\frac{1}{100,000}$ part of the atom in size. The balance of the atom is made up of negative electrons which possess the ability to shoot through anything except the nucleus of the atom.

A negative electron has about ten times the speed of a positive electron. The arrangement of the atoms of certain substances is such that electrons have great difficulty in passing, being backed up or deflected by the nuclei of these substances which are known to us as insulators. The best insulators are materials in which the nuclei lie closest together.

An idea may be had of the size of an electron by the fact that 1 gram of radium emits electrons at a rate of several millions per second and requires 20,000 or more years to be entirely consumed.

RADIOACTIVITY.

Radioactivity is the power of emitting rays capable of penetrating opaque substances. The first radioactive substance was discovered by Henri Becquerel in 1896, soon after the discovery of the x-ray. From that day to this 33 more radioactive elements have been discovered. There is probably no substance which is not more or less radioactive during its disintegration. Each radioactive element has a definite rate of transmutation, therefore a definite period of existence. Radiations from active bodies have been shown to consist of three kinds, known as alpha, beta and gamma rays. One or all of these rays is emitted during the disintegration of atoms, and new substances are continually being formed. It is possible that some day we may be able to so hasten the disintegration of matter as to be able, in one's life time, to bring true the dreams of the alchemists. The apparent impossibilities are the very things that help us to realize the possible.

Radioactive waters derive their properties from the emanations held by them in solution, gathered by the passing of the water through and over the rock matter containing radioactive substances. The atoms of radioactive emanations being very unstable, it can be readily understood that the gas will remain in the water but a very short time. The only way to drink real radium water and secure its therapeutic value is to drink it direct from the spring. Bottled radioactive water is a myth.

In "ye olden tyme" the thunder's roll and the lightning's flash were taken as positive proof of divinity, and it was the belief in those days that lightning was a manifestation of divine wrath. This electric manifestation filled the hearts of the Romans with fear, and the Greeks with inspiring awe.

In those days great effort was put forth to interpret the meaning of the lightning flash. Heaven's dome was divided into sections: when lightning appeared in one section, it was of evil omen; when in another, it was favorable; and when in still another, it was fatal to all undertakings. Warriors were guided in battle by these manifestations.

Centuries passed, kingdoms rose and fell, still the superstition prevailed. It was not until that philosophical printer, Benjamin Franklin, with his kite and key drew the monster from the clouds, that electricity was thought to be anything but the voice of Jehovah.

HISTORY.

The great Grecian philosopher, Thales, who lived some 2500 years ago, was probably the discoverer of electricity. The ancient Phoenicians found floating upon the waters of the Baltic sea a beautiful transparent gem. This gem, which we call amber, was named by the Greeks "electron." While this gem was highly prized by the ancients, Thales discovered that when rubbed by the hand it possessed the mysterious power of attracting to itself various light articles. He thought that he had discovered the hidden principle of life and that amber possessed a soul. It never occurred to him or other philosophers that there was any connection between the life of amber and the electricity of the thunder storm, nor that the gem electron was to give a name to the most wonderful of modern discoveries.

While the observations made by Thales were never lost, a period of over 2000 years elapsed before any great study of the properties of amber or electron was made. This study was made by an Englishman named Gilbert. His experiments astonished all Europe, and from his labors sprang the science of electricity.

Otto Guericke, a Prussian from the land of amber, invented the first electric machine, which consisted of a globe



Fig. 1.—First static machine, Guericke, 1630.

of sulphur on an axle to be turned by the hand while a cloth was applied to the globe. The friction of the cloth upon the sulphur brought forth sharp sparks of electricity. This was the beginning of what now is known as static electricity.

Even before the Christian era it was discovered that the world and the matter of which it consists were in motion. While we groped for centuries in atomic theories, we now have a scientific base upon which that theory rests. The discovery of the electron has in no way weakened the atomic theory, but has made it intelligible.

Professor A. W. Hull says: "The atom of 20 years ago was the 'hypothetical smallest subdivision of matter.' The atom of today is a real object of definite shape and size. We know what it is made of. We know its weight in grams. We can see it splash when it impinges on a plate of fluorescent material. We know its exact speed when it flies about a gas, and lastly, we know its exact position when it forms part of a solid body."

"When a narrow beam of x-rays passes through a fine powder of any crystalline material, it produces on a photographic plate placed just behind the powder a pattern of concentric circles. These circles are produced by the reflection of the x-rays from the planes of atoms in the crystal, and their diameters are a measure of the distance between these planes of atoms. By measuring the diameters of the circles the exact positions of the atoms can be determined."

Any clear night we see innumerable planets, each moving in its mysterious but well defined orbit. It requires 25,000 common years to make one platonic year, when all the planets assume the same relative position one to another. For an airplane, traveling at the rate of 200 miles an hour, 7 weeks will be required to reach the moon; 53 years the sun; 27 years Mars and 14 million years Alpha Centauri, the nearest star.

For a moment let us call each shining star a negative electron and the sun a collection of positive electrons. These negative electrons, together with the sun as a nucleus, make up an atom. The planets, each revolving in its own orbit, go on and on, never touching one another. Suppose some disturbance takes place like Halley's comet which has been going at electrical speed for hundreds of years, and strikes the sun or nucleus of the atom; it would be deflected, backed up or destroyed. This is precisely what takes place in the atom of any substance. An atom is a concrete thing

which may be seen—a tiny solar system with nucleus sun and electrons planets.

The constitution of the atom of any substance is necessarily an electrical one. Many negative electrons, which are capable of separate existence, may be taken from the atom without any particular effect upon the remaining electrons in the atom except lowering its potential and increasing the potential of the atom to which it escapes. The action of these escaping electrons is called an *electrical charge* and the result an *electrical current*. The physical features of electrons are their negative character, small volume and extreme speed. It requires a great disturbing power to break up an atom and to start electrons, when many rays known as light, alpha, beta, and gamma are produced, but when once detached little force is necessary to keep them going. If a target of high atomic weight be placed in the path of electrons, their speed is interfered with, they are deflected and x-rays produced. The production of x-rays, therefore, depends upon the separation of electrons from atoms, giving them high speed, concentrating them on a small area and stopping them suddenly. An electron always moves in a straight line until it strikes a positive nucleus, when it is deflected, and its course then depends upon the angle at which it strikes the substance causing its deflection.

At the point of concentration and deflection of electrons great heat is produced, sufficient to melt ordinary metal. This is the reason for choosing for x-ray targets metals of high melting points, such as tungsten and platinum. However, any known substance may be melted by the proper concentration and deflection of electrons.

When the generation of an electric current is spoken of, creation is not implied. A so-called electric generator does not create electricity—it simply separates the negative elec-

trons from the positive ones of the atom and pushes them in opposite directions.

In the mystical ages which preceded its discovery, electricity was considered an agent of Providence, and every phenomenon belonging at all to the unusual was attributed to a good or evil spirit. Fifty years ago the electrical knowledge of the world was confined to a few static sparks, a magnet, a voltaic pile and, possibly, the action of a faradic coil. From this feeble manifestation of fifty and, I might say, twenty-five years ago, electric current in the form of light, heat, and power has produced a revolution in the arts and sciences and channels of commerce, as well as in electrotherapeutics.

At the advent of the x-ray electrotherapy from a scientific standpoint was groping in darkness; but by lighting the pathway with enthusiasm and using the tools of empiricism (though with but little knowledge of the whys and wherefores), considerable progress was made in the treatment of disease. It was in the days of unsexing women for any reason, from pain in the occiput to ingrowing toe-nail, and conservatives were seeking for something to relieve the situation. It was *found* in the direct and high tension faradic currents. It was also found that we could stimulate circulation, improve nutrition, absorb exudates, ionically transmit medicinal substances and destroy neoplasms with the galvanic current and relieve pain with high tension faradism. True, enthusiasm carried us to untold heights, sometimes dropping us into the river doubt, while many were thrown into electrotherapeutic nihilism. We did many things which we, in our present state of knowledge, would not dare to do. Frank discussion of successes as well as failures; the discoveries of high frequency by d'Arsonval and Tesla; the enlistment of manufacturers in producing more efficient apparatus, together with un-

ceasing study of the action of the different modalities upon human organism has placed us upon a scientific basis and we are now able to know in advance what to expect from their use in pathological conditions. When the time comes when physical and electrotherapeutics are taught in our medical schools; when they have a sound basis in physiology and are scientifically applied, then, and not till then, will drugless healers disappear.

To medical men generally, electricity is a mystery and its effects only psychic. While few writers of books on neurology recognize the beneficial effects of electricity, the recommendations they make for its application engender a feeling of pity for their understanding of modern methods. Whenever the word electricity is used without specifying the modality to be used, a total lack of understanding is as apparent as in the statement "drugs may be tried" for this or that condition without specifying what particular drug should be prescribed.

No field in medicine offers greater encouragement for study and application than does that of electrotherapy. Electricity in its many modalities has greater power in restoring functional conditions and arresting organic changes than all the drugs mentioned in our pharmacopeia. Electricity is by no means a cure-all, but the wide range of its applicability, its vitalizing and stimulating force to every cell of the human body make it a resourceful agent in medicine.

The results of therapeutic value from any electric modality are in direct proportion to the skill of the operator. The harm resulting from the unskilled operation of these modalities emphasizes the necessity of a course of instruction in the use of electrotherapeutic apparatus.

While we are becoming comfortably seated in the chair of scientific electrotherapy we have not yet adopted a

uniform technic of application. Each operator, as he becomes more proficient, works out a technic satisfactory to himself, but there are certain basic principles that guide us all, and the better understanding we possess of those principles and a careful working out of the problems which confront us, the sooner will we be able to adopt a universal method of application.

Few things are more interesting and profitable than a study of the history of a science. However interesting and instructive it may be the space at our disposal precludes going deeply into the history of electrotherapeutics, but I may be pardoned for an occasional reference thereto.

John Wesley was the first person to write in the English language a treatise on electricity. I quote from his concluding remarks, as follows: "Before I conclude, I would beg one thing from the gentlemen of the faculty and all who desire health and freedom from pain, either for themselves or their neighbors. It is that they would none of them condemn they know not what; that they would hear the cause before they pronounce sentence; that they would not pronounce peremptorily against electricity while they know little or nothing about it. Rather let every candid man take a little pains to understand the question before he determines it. Let him for two or three weeks (at least) try it himself in the above named disorders. And then his own senses will show him whether or not it is a mere plaything or the noblest medicine yet known to the world."

Are not these words as true today as when uttered by that great preacher one hundred and sixty years ago? His apparatus consisted of a primitive form of static machine and the Leyden jar. He would insulate the patient, charge him with static electricity and draw sparks from his body. His method greatly influenced metabolism and he secured

results without having the slightest idea of how or why this was so.

James Graham was probably the first electricity quack. He flourished in England about one hundred and forty years ago, and from that time to the present the world has suffered from him and his ilk. Graham's chief specialty was the treatment of sterility, and its cure was effected by sleeping in the celestial bed at the modest fee of 50 pounds.

Franklin studied the effects of static sparks applied in accordance with the practice of his time. The use of electricity in medicine was confined to static sparks until the discovery of galvanism in 1791. This gave anew an impetus to quacks and it was heralded as a cure-all.

The discovery of faradism in 1831 was followed by more sensational claims. It was not until 1888-1890 that d'Arsonval evolved a method of treatment by high-frequency currents. This was followed by the Röntgen ray in 1895 and Tesla's modification of the d'Arsonval current. This was the beginning of electrotherapeutic science, and it has grown by leaps and bounds until we have what you see today.

The recognized effects of various electrical modalities of today regulate their use. Our knowledge is now sufficiently *definite* that certain rules may be laid down for *choice* of current and the amount of voltage and amperage required to produce certain results.

To discover is to bring to light something already in existence. To invent is to create something new, but the word "invent" is generally understood to stand for the same as "discover," it being impossible for man to create anything *ipso facto*.

Man has made many discoveries in methods of utilizing the potential power of electricity—in other words, transferring potential energy into kinetic energy.

ENERGY.

Energy may be defined as the capacity of overcoming resistance at a distance. Energy is displayed by the transference of work. A weight falling through space does work, but the energy displayed by its falling was transferred to it by some other work performed in raising it. A coiled spring can do work by unwinding, but some form of energy is expended in winding it. Compressed air does work by expanding. Different bodies do work by changing their position, their form or state. Everything possesses potential energy, and the extent of that energy is measured by its capacity (potential power) to do work or transfer its power, which means transformation of potential energy into kinetic energy.

The unit of measurement depends upon the nature of the substance with which we are dealing. The common unit of work is called an erg, which means the amount necessary to overcome a unit of resistance through a distance of 1 centimeter. In ordinary mechanics the unit of work is called a foot pound, meaning the amount of energy displayed in overcoming a resistance of 1 pound through a distance of 1 foot. A foot pound is not exact because it varies in different localities owing to the magnetic attraction of the earth at different points. In order to stop kinetic energy some work must be done and this may be measured. When a moving body is stopped its kinetic energy is transferred back into potential energy. No energy is ever lost, although many times it seems to be. Muscular energy is imparted to a spring in winding it. Suppose the spring after being wound is thrown into an acid which destroys it; what becomes of the energy usually exhibited by its unwinding? Its dissolution depends upon the transference of mechanical energy into electrical energy,

so there is nothing lost. This holds good in every display of energy known to man. While we do not always recognize just how or why, it is a self-evident truth. The potential energy of a body is always the same.

When kinetic energy is suddenly stopped it is transferred into heat energy, but the potential energy still remains in the body.

Energy cannot be created. Wherever or whenever energy is displayed it is only a power transmitted from an equal force in some other form. There is always an apparent loss occasioned by friction or resistance in the transfer from one form to another, but this loss is accounted for in heat energy. Energy always tends to return to its original form. Heat transfers water into steam, the expansion produces mechanical power, while it, in turn, passes back into heat.

The world was probably created with a definite number of electrons. While they have made many transfers of title, not one has been lost or a new one created.

In electrical engineering the first principle to be understood is that of energy. No work can be accomplished without it.

To transfer mechanical energy into electrical energy a dynamo is employed. A dynamo creates no electricity—it simply separates the electrons of the atom by agitation and pushes them apart, when they fly to the point of greatest attraction through a route of least resistance.

The weight of water falling through space transfers its potential energy into mechanical energy, and this energy is again transferred by the turbine wheel to the dynamo which again transfers it into electrical energy. The original source of all energy is electrical and it is more or less an easy matter to transfer it into other forms of energy and back again into its original form.

An electrical motor is a machine for the transference of electrical energy back into mechanical energy. An electric lamp is a device for the transference of electrical energy into another form called luminous energy or light.

Chemical energy can be converted into electrical energy. For example: the chemical energy of coal and other fuels cannot be converted directly into electrical energy, but it can be transferred into heat energy by combustion, the heat energy into mechanical energy and this, in turn, into electrical energy.

When energy is dissipated or converted into a form which we, in our present state of knowledge are unable to recover, we say that it is lost, but it is turned back into the great store-house, the Universe, from whence it came.

Electricity is universal. It exists in the waters of the sea, the rivers and every babbling brook. It exists in the sandy loams of our agricultural areas, in the mountain sides, in every blade of grass and in each tiny leaf and flower. It is in all forms of animal life and in the air that we breathe. Man has been able to bring about a redistribution of electricity by the aid of chemical and mechanical discoveries. He has been able to move it from one place to another and cause it to accumulate and do work by returning it to its former distribution.

I repeat: Electricity is universal, yet it never manifests itself as we understand it except when it is disturbed by mechanical or chemical means, and man has discovered the method of its conversion and made it his servant.

For convenience of description electricity may be classified according to its movements as:

1. Electricity in motion or current electricity.
2. Electricity in vibration.
3. Electricity at rest or static electricity.
4. Electricity in rotation or magnetism.

Other classifications are made, such as magnetic, static, dynamic, etc.

Dynamic electricity includes galvanism and faradism. Static electricity is sometimes called Franklinism.

Electricity is also classified as positive and negative.

Static electricity is produced by friction. It manifests itself by attraction and repulsion, and when discharged it produces more or less of a current.

Electricity in motion, or current electricity, may be defined as the quantity of electricity or the number of electrons which pass through a conductor in a stated time.

Electricity in vibration is when the current oscillates or vibrates back and forth with great rapidity. When the rapidity is extreme it is called a high-frequency current.

Heat and light are forms of electrical vibration.

The source of light has been one of the mysteries of science for ages. The discoveries of Maxwell and Hertz that light is simply electric vibration caused scientists to look for the electric charges which cause the vibration.

Bohr says that light is given off when the electron is suddenly changed from its normal motion, by jumping from one atom to another or from one orbit to another about the same atom.

Electricity in rotation or magnetism in a substance may be shown by its power of attracting iron filings, needles, etc.; by attracting and repelling other magnets; by its power to impart its magnetic properties to iron or steel and by arranging itself, when suspended, so as to point to the north and south poles of the earth.

Positive Electricity: This term applies to a condition of stress or high potential—the north pole of a magnet. It is represented by the plus sign (+) indicating a large amount.

The term negative electricity signifies the opposite of positive, meaning a point of less electrical stress or potential, and is represented by the minus sign (—).

The terms vitreous and resinous as applied to electricity have become obsolete.

From time to time electrical terms will be used, and it may be well at this time to define some of them.

VOLTS, AMPERES, OHMS, AND WATTS.

Voltage may be defined as the amount of power exerted in separating an electron from the atom; the tension between the terminals of a primary cell; the stress of trying to pass a charge from one place to another.

A volt is the unit of electrical stress or pressure—the power exerted to push 1 ampere of current against a resistance of 1 ohm.

An ampere is the unit of electrical current—the amount of electricity that will pass through a conductor that offers 1 ohm of resistance to the pressure of 1 volt. Water is measured in gallons, electricity in amperes. The strength of the current or rate of flow is called amperage. It depends upon the number of electrons passing in one second of time. The legal definition of an ampere is the amount of current that will deposit 0.001118 gram of silver per second in an electroplating cell. It will decompose 0.000945 gram of water per second.

An ohm is the unit of electrical resistance. An ohm is equal to the resistance offered by one foot of No. 40 copper wire or one mile of trolley wire. Legally it is equal to the resistance offered to an unvarying current by a column of mercury at 32° F., 14.4521 grams in mass of a constant cross sectional area and the length of 106.3 centimeters.

Ohm's law is: The amount of current in amperes is

equal to the electromotive force in volts divided by the resistance in ohms. ($\frac{\text{volts}}{\text{ohms}}$ equals amperes).

Volts and ohms may be illustrated by a man applying force to open a door while another man on the opposite side applies an equal force in resistance. No. 1 will be able to open the door in proportion to the lack of the force applied by No. 2. No. 1, trying to push the door open, is Mr. Volt; No. 2, who is resisting the force of No. 1, is Mr. Ohm.

Another homely illustration may be presented of a pump forcing water through a pipe. The pump is Mr. Volt, the water is Mr. Ampere and the pipe offering the resistance is Mr. Ohm.

A coulomb of electricity is the unit of electrical charge. One ampere of current will carry 1 coulomb in one second of time. Ten amperes will carry 50 coulombs in five seconds. An electrical charge or coulomb is determined by multiplying the number of amperes by the number of seconds of time in which it is passing.

A watt is the unit of electrical work. It is the amount of power produced by a current of 1 ampere passing under the pressure of 1 volt; it is equal to about 44.2 foot pounds per minute.

One horsepower is equal to 746 watts. The amount of work performed may be determined by multiplying the number of amperes by the number of volts. One kilowatt is equal to 1000 watts.

A watt hour represents the amount of work done by a current strength of 1 ampere passing for one hour under pressure of 1 volt. An electric lamp receiving $\frac{1}{2}$ ampere of current on a circuit having a pressure of 110 volts will consume 55 watts of work. This multiplied by the number of hours will give the amount of watt hours.

The reciprocal relations of electrical units may be thus expressed: Volts times amperes equal watts. Amperes times ohms equal volts. Amperes times seconds equal coulombs.

An electric current is simply the passage of electrons over a conductor. A conductor may be defined as a bridge of suitable material for the passage of electrons from one place to another.

In order to conduct water from one place to another, a suitable pathway must be had. To force water against a resistance, power is required in the form of a pump or head pressure of some kind.

In order for electricity to be transferred from one place to another, a conductor is required. A conductor for the passage of electrons offers resistance in itself, consequently pressure must be brought into play to force the electrons over the bridge. This pressure is called electromotive force or voltage.

There are many conditions that set electrons free from the atom. The mere contact of dissimilar substances, chemical action, difference in temperature, friction, the entrance of a substance into a magnetic field, all produce a flow of electrons which we are pleased to term an electric current.

The flow of an electric current is proportional to the voltage and inversely proportional to the resistance, the latter depending upon the material, length, and character of the conductor.

As electricity flows along the line of least resistance, the conductor must be well insulated to prevent leakage. When the current leaks or escapes from the conductor and fails to do work, it is known as short circuit.

A lead conductor is one which conducts the current from its source, and the one by which it flows back is called the

return. When wires are used for both lead and return it is known as a metallic circuit. When the ground is used for the return it is called a ground circuit.

Currents of electricity may be obtained chemically, thermally, and mechanically. The chemical method is best represented by immersing two dissimilar metals called elements, such as copper and zinc, in a fluid called an electrolyte. This contrivance is called a primary or voltaic cell. A difference of potential is produced by chemical action of the electrolyte upon the zinc. The chemical action upon the zinc raises its potential and sets the electrons of the atom free; they are conducted through the electrolyte to the point of least resistance, which, in this case, is the metal copper. If the copper and zinc be connected by a wire (conductor) outside the cell, a passage of electrons takes place which is called an electric current.

It is not known whether the electric current coming from a primary cell is due to the chemical action of the electrolyte on the elements of the cell or the flow of electrons from a higher to a lower potential causes the chemical change in the electrolyte.

Nearly all textbooks on electricity state that the direction of the electric current in the external circuit is from positive to negative. Some most interesting experiments have been made by teachers in radio schools that tend to prove that in reality the flow of negative electrons is from the negative to the positive pole. My own idea is that the chemical action of the electrolyte upon the zinc element of the cell sets the negative electrons free from the atom, leaving the positive electrons with the zinc: consequently the current is composed of negative electrons. Taking away negative electrons from the atom leaves it in a positive state.

It has been demonstrated that the electrons passing in a vacuum x-ray tube are negative, and one is not entirely blamable for believing that the same thing occurs in a wire conductor, although there is a possibility of the abhorrence of a vacuum by positive electrons.

As physicians it need not concern us whether an electric current consists of one stream of negative electrons or one positive and one negative stream. We are principally interested in the effects of electric currents upon the human body, and we know that we get polar effects from a galvanic current, and we are also aware of the different effects from a positive and negative pole of a static current.

When the junction of two dissimilar metals is heated electrons are set in motion, and if the opposite ends of the metals be connected by wire, the electrons will follow the wire and thus constitute an electric current which will continue as long as difference in the temperature of the ends of the metals is maintained.

We know that the two terminals of a current differ in their chemical effects upon the tissues. We know that oxygen is set free at one pole commonly called the positive, and that hydrogen is set free at the other terminal known as the negative pole. The positive pole causes dryness of the tissues and an acid reaction; the negative pole causes moisture of tissues and an alkaline reaction. The acid pole (positive) produces a dry eschar which is difficult of removal, while the other pole (negative) produces a soft eschar which is capable of being absorbed.

The effect of a constant current upon human tissues is an electrolytic one. We have every reason to believe that the passing of the constant current through the tissues of the body has an electrolytic effect upon all the tissues through which it passes as well as at the poles.

We know that in the separation of an electrolyte into its component parts within a primary cell that the hydrogen particles collect upon the element from which the current leaves the cell. The element to which the hydrogen atoms adhere is called the negative element, but when the electrons escape from this negative element to a conductor which leads back to the positive (zinc) element we call it the positive pole; in other words the polarity within the cell is opposite the polarity outside the cell.

In order to practice medicine successfully a physician must be possessed of a thorough knowledge of its groundwork, anatomy, physiology, chemistry, pathology, biology, bacteriology, laboratory methods, and therapeutics. He must also have that training necessary to give him a keen perception and, I might say rare ability to diagnose pathological conditions. He must have good judgment and good technic although not too scientifically technical; be able to call laboratory methods to his assistance without sole dependence upon them. It is better to confirm a clinical diagnosis by laboratory methods than to try to make your clinical data conform to the laboratory findings. Many times a real live clinical diagnostician will have his patient well while the too technical man will still be inspecting microscopic slides and test tubes.

In order to be a successful electrotherapist you must have all the knowledge possessed by the medical man, and, in addition thereto, the knowledge of what electricity will do and be able to apply it accurately.

We often hear such remarks as "I have tried electricity and there is nothing to it." When I have seen acute bronchitis and pulmonary congestion relieved by one treatment by thermopenetration; when I have seen men who were wedded to a catheter life from prostatitis permanently restored to a natural condition by its application; when I

have seen more patients benefited by it than I have by drugs during forty years of practice, and, by its means we are enabled to extend our vision through the human body and have its framework made as plain to us as is the framework of the bridge to the engineer, to tell me there is nothing in electricity *except its psychic effects* is to deny my very existence.

While I am a believer in and an enthusiastic advocate of electrotherapy, I do not desire it to be understood that I am a disbeliever in the efficacy of drugs. We have a few drugs that are of supreme importance in therapeutics, and hundreds of others of no importance. How disappointing it is when, consulting a reference book on the treatment of different diseased conditions, we find there recommended a list of from ten to forty drugs. Whenever we see a large number of drugs recommended for any disease, we know, only too well, the uselessness of *any* of them—large in quantity, always poor in quality.

The practice of electrotherapeutics is not a shotgun proposition, but rather a bull's-eye shot. When a definite pathological condition is diagnosed there is a definite line of treatment to be applied. We do not say that galvanism, faradism, static sparks, diathermy, auto-condensation or vacuum effluve *may be tried*. To be sure there may be conditions to which different modalities may be applied with benefit, but it still remains that the highest efficiency lies in one particular scientific application.

Electrotherapy will not remove every pathological condition. In many instances it is not unlike drugs—only palliative. In the practice of electrotherapeutics if you will be consistent and not attempt the impossible you will experience less vexation of spirit and more satisfaction to yourselves and to your patients than you have ever before dreamed of.

When we look back over the road that was surveyed by Thales, and cleared by such men as Galvani, Faraday, Franklin, d'Arsonval and Tesla, we see by the wayside, as the result of their work, brambles of superstition and boulders of ignorance. This work was done by infinite toil and self-denial. Their food was aspiration and unfailing courage and a self-consciousness of lifting the lid of Nature's chest and exposing some of her precious jewels. Generation after generation has taken a peep into that chest and brought those jewels into view of an astonished world. Over the ashes of such heroes of the past should be written the greatest of epitaphs, and upon the brows of those remaining should be pressed the crown of ceaseless gratitude.

CHAPTER II.

DYNAMIC ELECTRICITY.

Electrons. Types of primary cells. Open and closed circuits. Voltage. Amperage. Potential. Direct and rectified currents. Resistance. Electric meters. Conductivity. Magnets and magnetism. Laws of magnetic induction. Magnetic field. Solenoid. Hysteresis. Residual magnetism.

ELECTRONS.

LET us start upon a little journey which will lead us through more or less dry territory. The road is beset

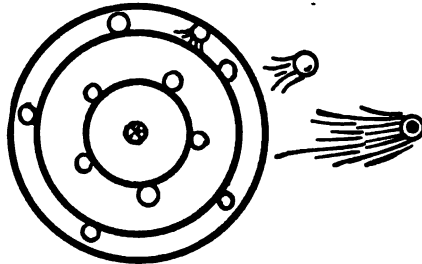


Fig. 2.—Electrons traveling a regular orbit about a positive nucleus. Moving from one orbit to another produces light.

with many lines of force and the better we understand the principles of the obstacles in our pathway the easier will be the work later on.

In the previous chapter the electron was referred to as being the basis of all fundamental matter. The diagram (Fig. 2) illustrates an atom made up of electrons. The center represents the nucleus which is composed of positive electrons and representing about $\frac{1}{100,000}$ part of the diameter of the atom and approximately one-half its

atomic weight. The small circular figures represent the negative electrons which are always traveling in a regular orbit about the nucleus. They are apparently moving in the magnetic field of the positive nucleus and any disturbance in their movements sets these electrons free to join



Fig. 3.—Waves of galvanic current.

electrons of adjacent atoms which in turn are disturbed and set free, producing what we are pleased to call an electric current. Whenever an electron moves from one orbit to another, or escapes from the atom, light is produced.

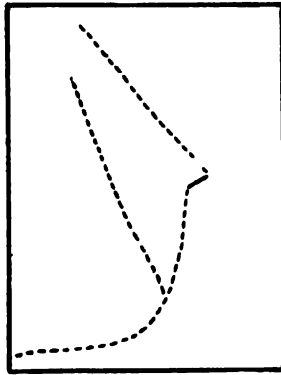


Fig. 4.—Drawing from an actual photograph of electrons.

Fig. 3 illustrates the wave movement of a current passing through a conductor. The waves are regular and about one millimeter in length. The wave length varies somewhat with the voltage. The proof of the wave movement may be demonstrated by placing upon a charged wire a glass plate or cardboard upon which iron filings

are sprinkled. The waves of a galvanic current, however, are imperceptible to tactile sensibility.

Fig. 4 is a schematic drawing from a photographic plate showing streams of electrons after gathering other electrons from adjacent atoms of the substance through which they pass.

Fig. 5 is a diagram from a photographic plate showing shooting electrons through the air. They are approximately $\frac{1}{10,000}$ of an ion in size.

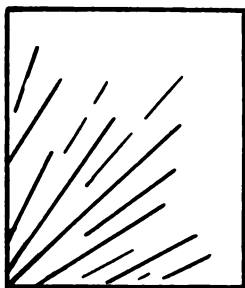


Fig. 5.—Drawing from photograph of streams of beta particles.

TYPES OF PRIMARY CELLS.

Fig. 6 illustrates a Daniell coil for closed circuit work. This cell will maintain a constant current for a long time. From time to time it will be necessary to renew the copper and zinc elements. The outer vessel consists of a glass jar in which there is a solution of sulphuric acid—1 part of acid to 20 parts of water. Inside the jar is placed a porous pot the top and bottom of which have been dipped in melted paraffin and which contains a strip of copper plate and a saturated solution of copper sulphate to which is added a quantity of copper sulphate crystals. A zinc rod is placed outside of the porous pot and in the acid solution. It will be necessary from time

to time to renew the acid solution. The chemical reactions which take place in this cell are as follows: The zinc dissolves in the acid solution producing sulphate of zinc, setting free hydrogen gas which passes through the porous pot. When it reaches the copper solution it displaces some of the copper, forming a solution of sul-

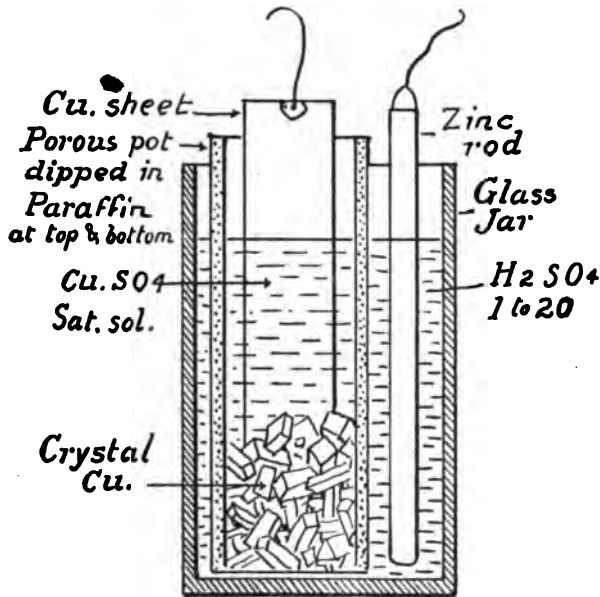


Fig. 6.—Daniell closed circuit.

phuric acid. The copper which is set free is deposited on the copper plate which prevents polarization.

There are many forms of primary cell. An open circuit cell is used when its service is required for a short time, as in electrotherapeutic work, electric bells, etc. A closed current cell is the type used when a continuous current is required, as in telegraphy, etc.

The closed type of a cell may contain a fluid in which both metal plates are immersed in the same solution, or

it may have two fluids when each plate is immersed in a separate solution. In this case one of the fluids is contained in a porous cup which is immersed in the other solution (Fig. 6).

Then there is the so-called dry cell (Fig. 7). If it

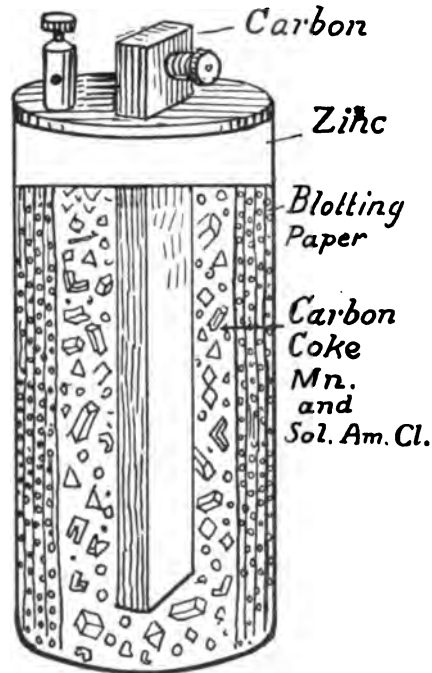


Fig. 7.—Dry cell.

were absolutely dry, no current would be forthcoming. This cell is composed of two elements, usually zinc and carbon, and a fluid electrolyte. A zinc cup open at the top forms one electrode. The cup is lined with several layers of blotting paper or other absorbing material. The other electrode consists of a carbon rod placed in the center of the cup. The space between is filled with

ground carbon or coke and dioxide of manganese mixed with an absorbent material and the filling moistened with a solution of ammonium chlorid. The top is closed with pitch to prevent leakage and evaporation.

The different types of cells usually take the names of the men who devised them. To obviate confusion in

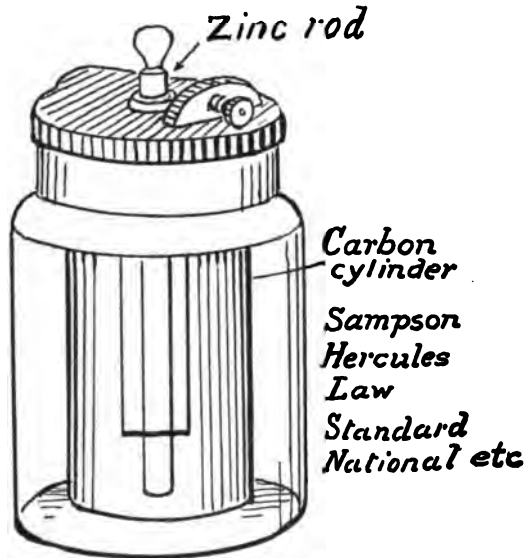


Fig. 8.—Carbon cylinder, open circuit cell.

your minds let us think of but one, the carbon cylinder type (Fig. 8), the elements of which are zinc and carbon; the zinc rod being placed within the carbon cylinder and the electrolyte being a solution of ammonium chlorid. This cell has an electromotive force of a little more than 1 volt. For practical purposes we say that it possesses the power of 1 volt which is fairly constant. However, it is susceptible to punishment and will not go on forever without renewal of elements and electrolyte any more

than a fire will burn without fuel; but when treated with respect it will serve us well.

A primary cell of 1 volt pressure is sufficient to drive 1 ampere of current through 1 ohm of resistance regardless of the size of the cell. Its capacity cannot be increased by enlargement of the elements. If more volt-

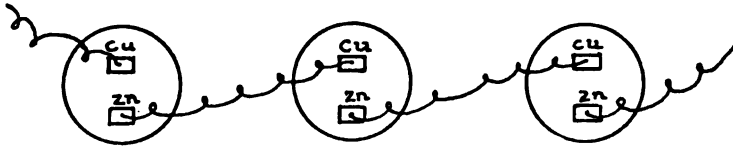


Fig. 9.—Cells connected in series.

age be required it will be necessary to connect up more cells in the circuit. The connections must be made in series (Fig. 9): that is, carbon to zinc, etc. When connections are made of all the carbons and all the zincs of a battery they are called connections in parallel or mul-

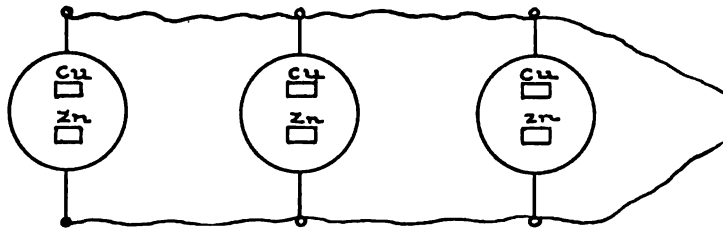


Fig. 10.—Cells connected in multiple.

tiple, (Fig. 10). Such connections are made when a large amount of current (amperage) is required with but little voltage. A battery of 40 cells connected in series will give approximately 1 ampere of current with a pressure of 40 volts. If connected in multiple we have 1 volt and 40 amperes. Increasing the surface of the elements increases amperage but not the voltage, the effect of con-

nection in multiple being the same as though the combined surface of all the zincs and carbons were in 1 cell.

"One robin does not make a summer," neither does 1 cell make a battery. A battery consists of 2 or more cells. In electrotherapeutics a battery of less than 40 cells is hardly sufficient for the work we wish to do. A battery capable of giving 60 to 100 volts is required to deliver the amperage needed in many cases.

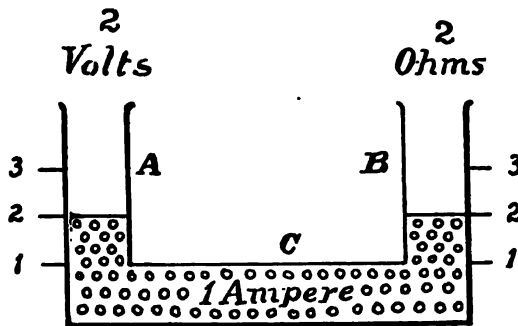


Fig. 11.

VOLTS, AMPERES, AND OHMS.

The terms voltage, amperage, ohms, and potential are the stumbling-block which the beginner in electrotherapeutics meets.

Ohm's law, the basis of all electrical computations, is: Amperage equals voltage divided by ohms. The following diagrams are submitted with the hope that they will aid in the understanding of these terms.

Fig. 11 represents 2 tubes in an upright position connected with another tube at the bottom. If water be poured into tube A it will pass rapidly to tube B and will continue to pass until the water in tube B is on a level with the water in tube A. For the purpose of illustration let us assume that tube A is filled with electrons to a

certain point; they will continue to pass over to *B* in the same manner as the water until the pressure in *B* equals that of *A*. There is this difference in the analogy: Any number of volts resisted by a like number of ohms will always allow the passing of a current of electricity of 1 ampere. In this illustration we have 2 volts of pressure

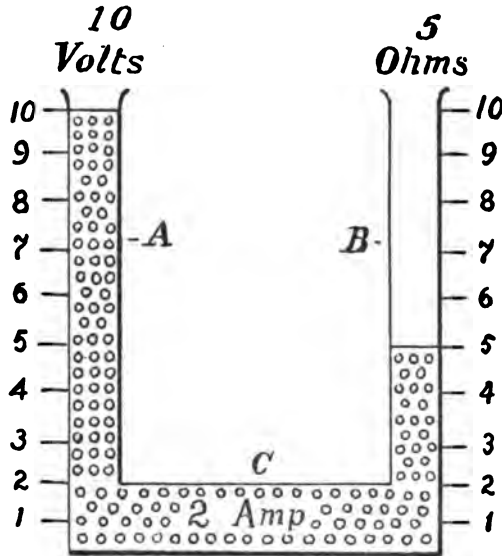


Fig. 12.

acting against 2 ohms of resistance, resulting in 1 ampere of current.

In Fig. 12 we have 10 volts acting against 5 ohms. Applying Ohm's law we have, 10 volts divided by 5 ohms equals 2 amperes.

Fig. 13 illustrates Mr. Volt trying to open a door with Mr. Ohm resisting. Mr. Volt is able to open the door slightly, allowing a current of air (amperage) to pass. The resistance offered by Mr. Ohm is able to hold the force of Mr. Volt when the door is opened to a cer-

tain distance, allowing a unit amount of air (amperage) to pass. It is quite evident that if Mr. Volt were assisted by 2 brothers, each equal in strength, also if Mr. Ohm were assisted by 2 brothers, each of the strength of Mr. Ohm, the door would remain in the same position and the same amount of air (amperage) would pass. If there



Fig. 13.—Mr. Volt and Mr. Ohm.

were 4 Messrs. Volt and 2 Messrs. Ohm there would be an increase of open space, allowing twice the amount of air (2 amperes) to pass.

POTENTIAL.

The term "potential" seems to be the hardest to understand. Every material thing possesses energy or pent-up strength ready to be let loose under proper conditions. Therefore, potential is ability to do work or energy at rest. One substance may possess a higher degree of con-

served energy than another; it is then said to be of a higher potential. Electricity flows from a higher to a lower potential as water flows from a higher to a lower level.

Fig. 14 illustrates the action of water in a U-shaped tube. Water in *B* will pass to *A* until the pressure in each arm of the tube is the same, when all flow ceases; but if there be an increased supply in *B* there will be a continuous flow through *C* to *A*, so long as the head pressure in *B* is higher than in *A*. Allowing the substitution of

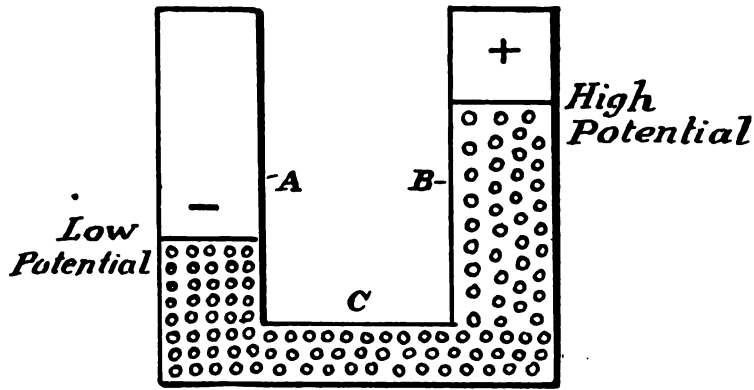


Fig. 14.—Illustrating potential.

electrons for water in the tube, it will be readily understood that as long as the pressure in *B* is higher than in *A* there will be a passage of electrons through *C*. Head-water pressure is analogous to high potential and represented by the plus sign, and low-water level to low potential represented by the minus sign. As long as the high potential is maintained there will be a flow of electrons toward the low level or potential. The amount of electrons passing through *C* will depend upon the pressure or voltage in *B* and the resistance or ohms in *A*.

Figs. 15 and 16 further illustrate potential in comparison to water pressure. The higher and larger the

water pipes the higher the head pressure. The higher the potential or voltage in the conductors and the larger the conductors, the less is the resistance to the flow of electrons.

In Fig. 15 the more water required by the water motor, the more power required to drive the pump. In Fig. 16, the more electrons required by the motor, the

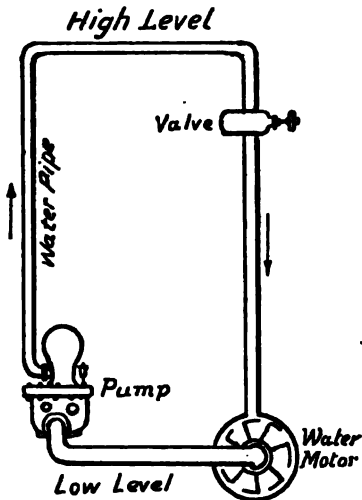


Fig. 15.

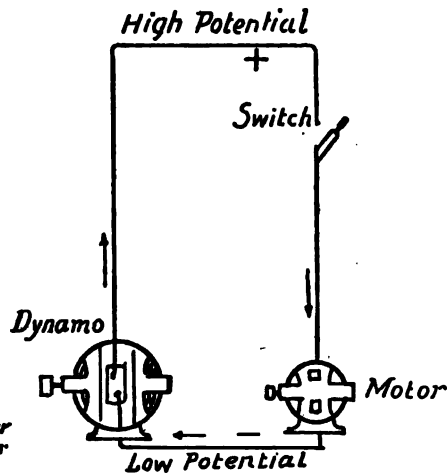


Fig. 16.

more power (potential) required of the dynamo. In these diagrams (Figs. 15 and 16)

The pump	equals	the dynamo.
The high level pipe	"	high potential positive conductor.
The low level pipe	"	low potential negative conductor.
The valve in pipe	"	the switch in electric current.
The water motor	"	the electric motor.
The water head or pressure	"	voltage, or electric pressure.
The flow in gallons per minute	"	the number of amperes.
The size of the pipe	"	the size of conductors.
The foot pounds or horsepower	"	watts.

DIRECT AND RECTIFIED CURRENTS.

The expense and petty annoyances of keeping up a battery are of considerable moment to a busy physician. City lighting systems are able to furnish us with either a direct or alternating current. In case the current be an

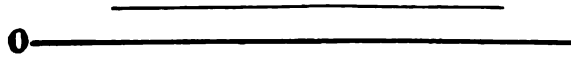


Fig. 17.—Galvanic current.

alternating one, to secure a direct or continuous current, all that is necessary to do is to install a so-called motor generator. Such a current is not a galvanic current, but does all the work required of a galvanic current.



Fig. 18.—Dynamo current.

Fig. 17 is for the purpose of illustrating a galvanic current. While it is absolutely smooth in sensation the movement of electrons is undulating, as heretofore mentioned (Fig. 3).



Fig. 19.—Chemically rectified current.

Fig. 18 illustrates a direct current from a dynamo. While a dynamo current is direct in movement the waves of electrons are more or less cut into at each revolution of the armature, but not sufficiently so to interfere in electrotherapeutic work.

Fig. 19 shows the sharp variations of an alternating current which has passed through a chemical rectifier. A

potential equalizer attached to a chemical rectifier partially obviates these sharp undulations, but not sufficiently so to make its use desirable in electrotherapeutic work.

The physiological effects produced by a current of high voltage and low amperage are entirely different from those of a current of low voltage and high amperage. A dynamo may produce a current of high voltage and small amperage or one of low voltage and high amperage, according to the way it is connected up.

When a great amount of heat is required, as in welding, the voltage of a dynamo current is cut down by a

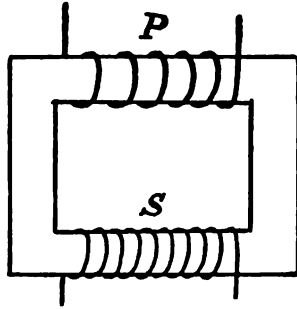


Fig. 20.—Closed circuit transformer.

step-down transformer, and when a large voltage is required, as in x-ray work, the voltage is raised by a step-up transformer (Fig. 20). While it is possible to produce x-rays from a battery of 60 good primary cells, a much more powerful current may be had from a 110-volt dynamo. The electric energy produced by the combustion of a ton of coal is 6 times greater than from the decomposition of 1 ton of zinc. So it is apparent that we should use the dynamo current for x-ray purposes.

A current of high voltage with a choked down amperage is more painful than a current with just sufficient voltage to overcome the resistance of the body and main-

tain the required amperage. In other words, a battery of 20 cells that will yield sufficient amperage to do the work required will irritate a patient less than one of 40 cells.

RESISTANCE.

The diagrams, Figs. 21 to 25 inclusive, will illustrate the effects of placing resistance in an electric circuit. Do not forget that resistance is measured in ohms. Fig.

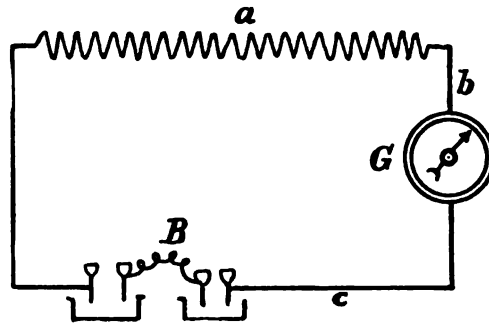


Fig. 21.—One resistance wire.

21 shows a continuous path along which electrons pass from and to a battery. In this circuit a resistance wire *a* is interposed between the battery and the galvanometer *g*. Notice the position of the needle of the galvanometer and note its degree of deflection. If another resistance wire *b*, in Fig. 22 of the same length and size as *a* be interposed in series with *a* the resistance will be doubled. Note also that the degree of deflection of the needle of the galvanometer is much less than in Fig. 21, due to the increased resistance. Now, instead of placing the resistances in series we place them in parallel, *b* and *c*, as in Fig. 23, having the same amount of resistance wire as in Fig. 22. The size of the wire has been doubled

but its length has not been changed, thereby allowing more electrons to pass and thus lowering the resistance. Note that the degree of deflection of the needle is double that in Fig. 21 and three times that in Fig. 22.

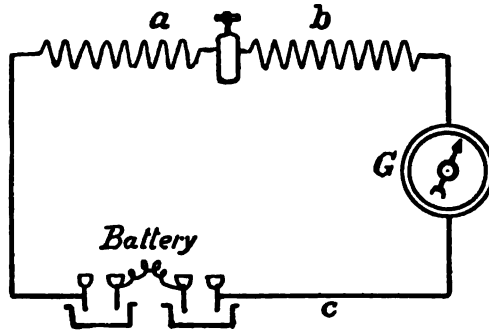


Fig. 22.—Two resistance wires in series.

In a compound circuit electrons will pass over the divisions of the circuit in proportion to their conductivi-

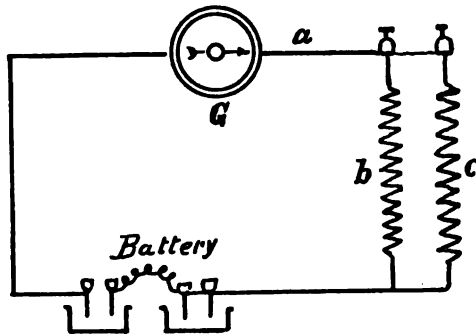


Fig. 23.—Two resistance wires in parallel.

ties. If in one route a resistance be interposed, the proportion of electrons passing through the resistance will be in inverse proportion to the amount of resistance offered.

In Fig. 24, *B* represents a battery the current flow or amperage from which is 100 milliamperes. *R* represents a shunt rheostat, *H* represents the patient. Each divided circuit is provided with a galvanometer. If the resistance of the rheostat is the same as that offered by the patient the galvanometer will show that the current is

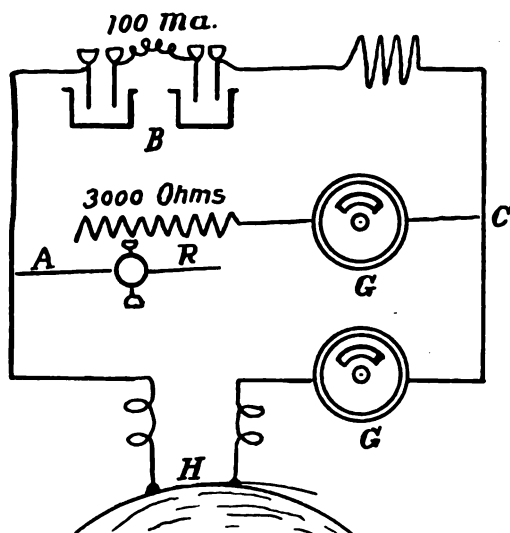


Fig. 24.—Shunt.

the same in each division, but if the resistance in *R* be increased there will be a change in the readings of the galvanometer; or if the resistance in *R* be diminished the readings will also be changed in another ratio. An increase in the resistance in *R* will allow more electrons to flow to the patient because electrons, like water, flow over the path of least resistance.

Fig. 25 illustrates a number of resistance coils, each coil possessing a known number of ohms. By a system

of plugs we can introduce into the circuit any number of ohms from 1 to 11,110.

The amperage of a current may be controlled by a shunt or a rheostat. The voltage is still there, but we have added the rheostat resistance to the passage of the current or have cut down the amount of current in proportion to the resistance offered by the control.

In electrotherapeutics the greatest resistance with which we meet is the human skin, which, from hand to

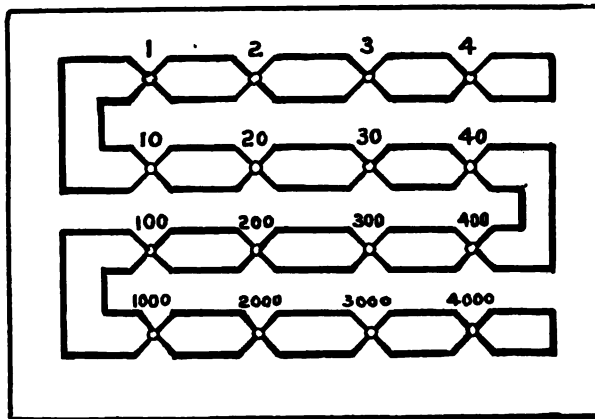


Fig. 25.—Resistance coils, 11,100 ohms.

hand is about 6000 ohms and according to Ohm's law requires a battery power of 60 volts to force 10 milliamperes through it.

The resistance offered by the skin may be reduced by wetting it with water; and if the water be saturated with sodium chlorid or sodium bicarbonate the resistance will still be lowered.

The resistance offered by the human skin varies in different parts of the body. While from hand to hand the resistance is about 6000 ohms with ordinary electrodes,

it may be as low as 1200 ohms in other parts, and on mucous membranes as low as 300 ohms. The larger the electrodes the less the resistance.

If the resistance offered to the flow of current were the same in each patient and we knew in advance the amount of resistance that would be offered from every part of the human body, then we would be able to know

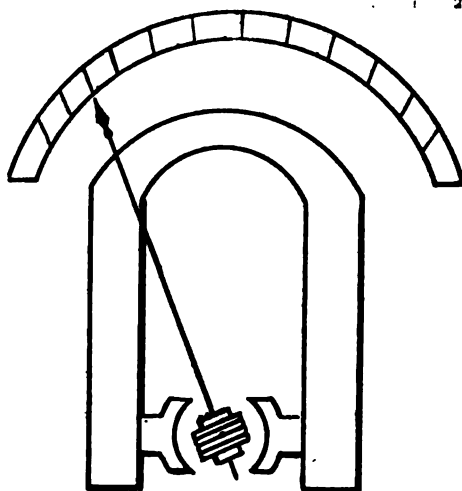


Fig. 26.—Milammeter.

just how many cells were needed; but as resistance depends upon so many conditions it becomes necessary to know the amount of current with which we are dealing: This to be ascertained by means of a milammeter.

ELECTRIC METERS.

A *milammeter* (milliampere meter) is simply a galvanometer so constructed that the deflection of the needle indicates directly the strength of current in milliamperes. A good milammeter should have a low resistance so that

very little of the energy of the current will be absorbed. The needle should be sufficiently sensitive to respond to the smallest variations of the current. In other words it should be *dead beat* or so damped that it will not oscillate, but come to rest at once.

The construction of a milammeter is a pointer at-

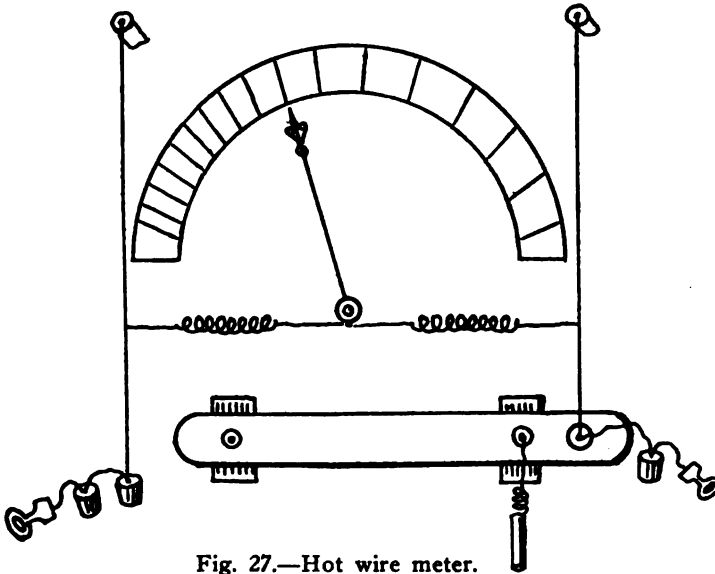


Fig. 27.—Hot wire meter.

tached to a moving coil pivoted between the poles of a permanent magnet—current passing through the coil causes the needle to turn against the restraining force due to the influence of the permanent magnet (Fig. 26).

A *voltmeter* differs from an ammeter simply in the winding of the coil. An ammeter coil consists of a few turns of heavy wire designed to carry a full current while a voltmeter coil is wound with many turns of fine wire. The ammeter is of low resistance and the voltmeter is of high resistance.

Every physician who is using a cell battery should have in his possession a d'Arsonval type of voltmeter for testing cells. No battery is stronger than its weakest cell. With the aid of a voltmeter each cell may be tested and the weak ones replaced.

A *hot wire meter's* action depends upon the heating of a conductor by the current passing through it, causing it to expand and move a needle, the movements of which, by calibration, are made to correspond to the pressure differences producing the current. They can be used on a direct or alternating current. They are liable to burn out on a sudden overload of current and are only approximately correct in their readings. They are used on all high-frequency machines (Fig. 27).

Rheostats.—In electrotherapeutic work it is absolutely essential that a means of controlling the current be at our command. It is often necessary to employ heavy currents which are free from discomfort when turned on and off very gradually. A suitable rheostat enables one to change the current more gradually than can be done with a cell selector. By means of a rheostat the current can be not only turned on and off gradually, but the amount reaching the patient can be limited. The principle of the rheostat is the introduction into the current of an adjustable resistance. This is accomplished in different ways. One form consists of strips of graphite, a sliding contact determining the length of graphite through which the current passes. Another form consists of strips of metal like German silver, long and thin enough to present the requisite amount of resistance. The length of resisting medium through which the current must pass is regulated by a sliding contact. Either of the forms just mentioned is efficient, but I prefer the one made of strips of metal.

A rheostat may be constructed with one or more incandescent electric lamps arranged in series so that the lamps and apparatus form a continuous circuit. This arrangement is sometimes advisable when using dynamo

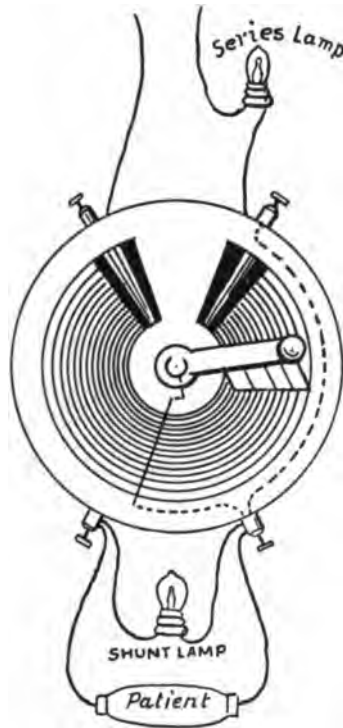


Fig. 28.—Graphite rheostat.

currents as the current strength may be limited to as small an amount as desired.

Fig. 28 represents a graphite rheostat. In this style of rheostat the graphite furnishes the resistance. In moving the slide contact clockwise, less and less resistance is offered until all is cut out and allows the full force

of the battery to reach the patient. This style of rheostat if well made is quite satisfactory. It allows of gradations in amperage from a fraction of a milliampere to the entire force of the battery.

Fig. 29 shows the principle of the rheostat placed in the main circuit. Whenever resistance is interposed in the main line it is evident that less current reaches the patient. The desired dose of electrons may be administered to the patient by regulating the resistance. When

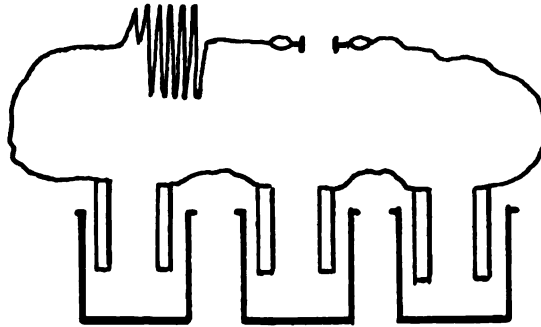


Fig. 29.—Principle of the rheostat, carrying whole current.

using a galvanic current from cells this principle should be employed.

Fig. 30 illustrates a rheostat in shunt. This plan is used when the current available is large, as from a dynamo. The more resistance placed in shunt circuit the more current will reach the patient. A shunt rheostat placed in a galvanic current would require a large number of cells just to overcome the resistance and thus entail unnecessary expense.

Fig. 31 shows a form of rheostat sometimes employed in commercial lines. It is not used in electrotherapy and is presented here only because it is used as a "starting

box" for electric motors. It consists of several resistance coils connected to brass buttons, Nos. 1 to 11. The resistance coils are placed in series between the buttons or contacts. As the lever is moved over the contacts the coils are successively cut out, thus diminishing the resistance until No. 11 is reached, when all resistance to the current flow is removed.

Conductors and Insulators.—Bodies in which the elec-

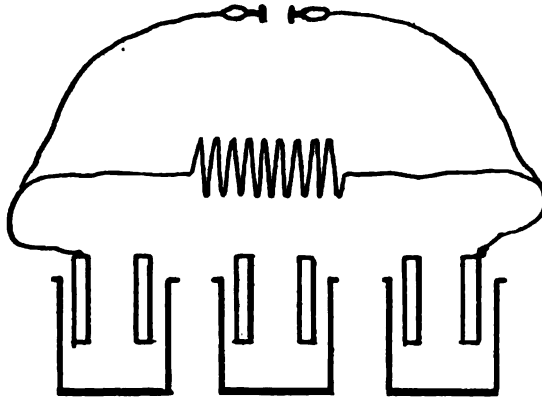


Fig. 30.—Rheostat in shunt, carrying part of current.

tric current moves freely are called conductors, and those in which it does not move freely are called insulators. The difference between a conductor and an insulator is one of degree only, for there is no known substance that is a perfect insulator. It requires but little voltage to move a big supply of electrons through some materials which we call conductors, while it requires great voltage to move a few electrons through other substances which we call insulators.

The most efficient conductors in the order named, are, silver, copper, aluminum, zinc, etc. The most effi-

cient insulators in order named are air, glass, paraffin wax, amber, jet, mica, shellac, etc. The earth is a good conductor as has been recently shown by using the ground in sending messages by wireless. Electrolytic copper is the metal universally used for conductors, no other metal approaching it in practicability.

The conducting power of bodies is affected by temperature. In the metals it is diminished by elevation of

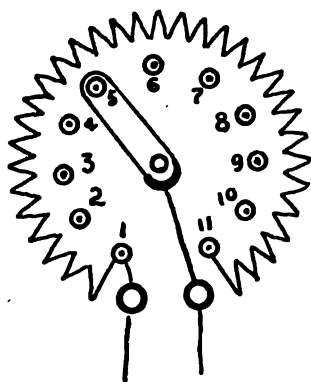


Fig. 31.—Coil rheostat.

temperature, but in all other bodies, especially in liquids, it is increased. Some substances which are insulators in the solid state become conductors when fused. Glass is one of the best insulators, but when it is raised to red heat it becomes a conductor. Sealing wax, pitch and shellac become conductors when liquefied by heat.

The passing of an electric current through any resisting substance produces heat. However, in the passage of currents used in electrotherapy through a well insulated copper wire, the heat is imperceptible. If a very small wire be employed to conduct a large amount of current (amperage), heat may be generated to a degree

of incandescence, as evidenced in galvanocautery. The nearer a substance approaches to being an insulator, the greater the degree of heat produced by an electric current.

Water, whether in form of liquid or vapor, is a conductor although greatly inferior to metals. The atmosphere contains, suspended within it, more or less aqueous vapor, the presence of which impairs its insulating property. The best insulators become less efficient if their surface becomes moist. When wires or cables are to be used under water the insulating material must be made impervious to water. Electric conductivity of metals depends on the ability of electrons to move between the atoms.

CONDUCTIVITY.

Metals in general conduct well on account of their low resistance, but they must not be too thin or too long lest they resist too greatly and allow only a small current to pass. Liquids of different kinds have different resistances. It requires a high voltage to force a current through pure water. Common salt or saltpetre dissolved in the water will lower the resistance because they are salts of metal and approach a metallic substance. Dilute acids are good conductors, but pure sulphuric acid is a poor conductor. Gases are bad conductors.

The laws of resistance of conductors are: (1) The resistance of a conducting wire is inversely proportional to the area of its cross section and, therefore, in a round wire it is inversely proportional to the square of its diameter. (2) The resistance of a conducting wire is proportional to its length. (3) The resistance of a conducting wire of given length and thickness depends upon the material of which it is made; that is, upon the specific

resistance of the material. In illustration of the laws of resistance of conductors it may be mentioned that if the resistance of a wire 1 mile long be 13 ohms that of 50 miles will be 50×13 or 650 ohms.

Ordinary telegraph wire is about $\frac{1}{6}$ of an inch thick. A wire twice as thick would conduct four times as well, having four times the area of cross section; hence an equal length of it would have only one-fourth the resistance (Fig. 32).

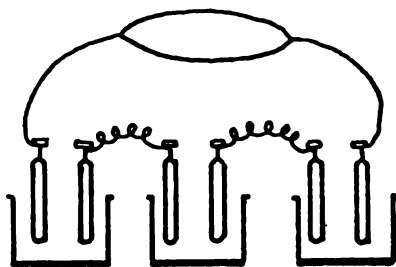


Fig. 32.—Divided circuit, with two conductors in parallel.

If a circuit be divided into two branches and united again, the current will be divided, part passing over one and part over the other branch; and the relative strength in the two branches will be in proportion to their conductivities—conductivity being the reciprocal of resistance.

MAGNETS AND MAGNETISM.

As such, magnetism is not employed in medicine except, possibly in the tests made by the Abrams' method of eliciting reflexes. If it were not for the important rôle it plays in high frequency and x-ray work, no mention of it would be made as there is no evidence at the present time of its possessing any therapeutic value outside of removal of particles of steel or iron from the eye by powerful electromagnets. However, literature is teem-

ing with exaggerated reports of the effects of magnetic therapy.

André Ampère (born 1775, died 1836) propounded his theory of electro-dynamics in 1820. He was first to show that two parallel conductors carrying currents in the same direction attract each other, while if traveling in opposite directions they repel each other. He advanced the theory that there were currents of electricity circulating in the earth in the direction of its diurnal revolution which attracted the magnetic needle. He also advanced the view that electricity and magnetism were identical. Ampère's theory of magnetism as advanced by him is that around each molecule of a magnetic substance there circulates continually an electric current, and that the process of magnetization consists in arranging these currents so that they all take the same direction.

Magnets possess two opposite kinds of magnetism or magnetic poles which attract or repel each other. One has a tendency to move toward the north and the other toward the south.

There are three kinds of magnets, the natural or loadstone, the permanent and electromagnets. The permanent ones are the bar and horseshoe magnets. The horseshoe magnet will attract more than the bar magnet because both poles act together. A magnetic needle consists of a small bar magnet, supported upon a pivot or suspended so that it is free to turn in a horizontal or vertical plane. In the northern hemisphere the north pole of the needle is depressed; in the southern hemisphere the south pole is depressed.

The strongest magnetism exists in the ends of the magnet and gradually becomes less until the center is reached where there is no magnetism manifest. When a bar magnet is held under a piece of cardboard upon which

are sprinkled iron filings, the filings will arrange themselves in curved lines radiating from the poles. These lines are called *lines of force*; they show that the medium surrounding the magnet is in a state of stress. The space so affected is called the *magnetic field*.

Fig. 33 illustrates the movement of lines of force when magnets possessing the same kind of magnetism approach each other. Fig. 34 illustrates the behavior of the lines of force when magnets of opposite polarity approach each other.

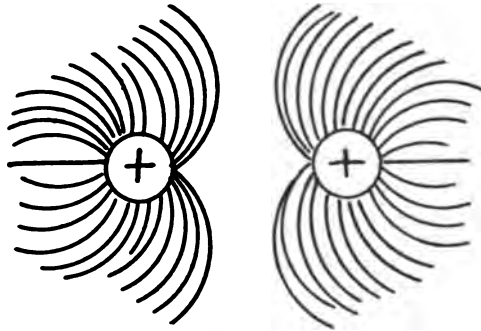


Fig. 33.

The influence of a magnet is supposed to extend in all directions indefinitely. If a bar magnet be broken each part will be found to be a complete magnet. No matter how finely subdivided, the results are the same. The laws relating to magnetic force are: (1) Like magnetic poles repel one another, (Fig. 33); (2) Unlike poles attract one another (Fig. 34); (3) The force exerted between two magnetic poles varies inversely as the square of the distance between them.

The path taken by magnetic lines of force is called a magnetic circuit. The greater part of such a circuit is usually in magnetic material, but there is often one or more air-gaps included. The total number of lines of

force in the circuit is known as the *magnetic flux*. The amount of magnetism passing through every square centimeter of a field of unit density is called a *maxwell*.

If a current flows through a loop of wire the lines of force will cross the plane of the loop at right angles, completing a circuit about the wire. These lines of force must be thought of as closed loops linked with the current. This arrangement of lines of force may be illustrated with several rings thrown over a standard.

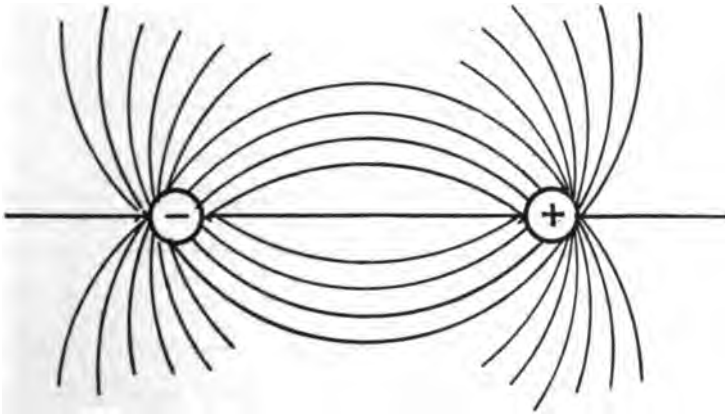


Fig. 34.

Fig. 35 illustrates a coil in a magnetic field. If the coil be moved within the field, say from *a* to *b*, there will be no current induced in the coil because the lines of force have not been changed; *i.e.*, during the movement from *a* to *b*, since as many lines are lost as gained.

Fig. 36 shows the essential condition for current induction. If in moving a coil from *a* to *b* the lines of force be changed by tilting the coil so that the number of lines of force are changed, a current will be set up in the coil by induction. Note that the number of lines of force cut at *a* are six and at *b* four.

The laws of magnetic induction are: (1) To induce a current in a circuit there must be a relative motion between the circuit and a magnetic field and of such a kind as to alter the number of magnetic lines embraced in the circuit. (2) The electro-motive force induced in a circuit is proportional to the rate of increase or decrease in the number of magnetic lines embraced in the circuit. (3)

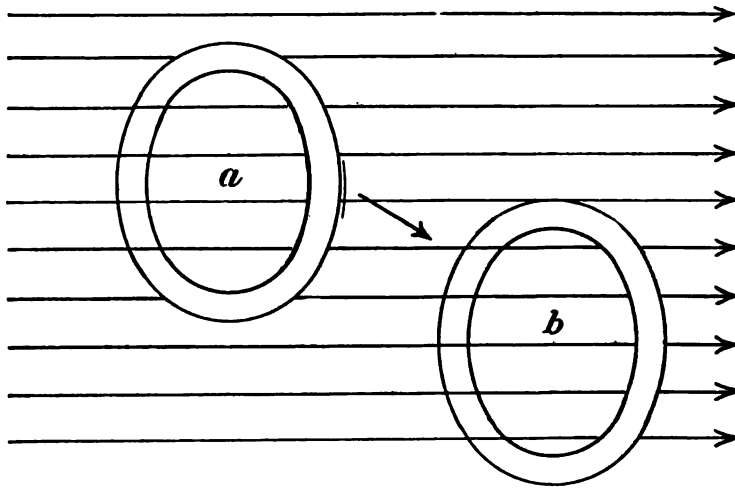


Fig. 35.—Lines of force unchanged.

By joining in series a number of conductors or coils moving in a magnetic field the electro-motive force in the separate parts are added together. (4) A decrease in the number of magnetic lines which pass through a circuit induces a current around the circuit in the positive direction. (5) An increase in the number of magnetic lines which pass through a circuit induces a current in the negative direction around the circuit. (6) The approach and recession of a conductor from a magnet pole will yield currents alternating in direction. (7) The more

rapid the motion the higher will be the induced electromotive force. (8) Lenz's law: The direction of the induced current is always such that its magnetic field opposes the motion which produces it.

The unit of electromotive force, called a volt, is the electric pressure produced by cutting 100,000,000 lines per second, usually expressed 10^8 . If a coil of wire of fifty turns cut 100,000 lines in $\frac{1}{100}$ of a second the induced voltage

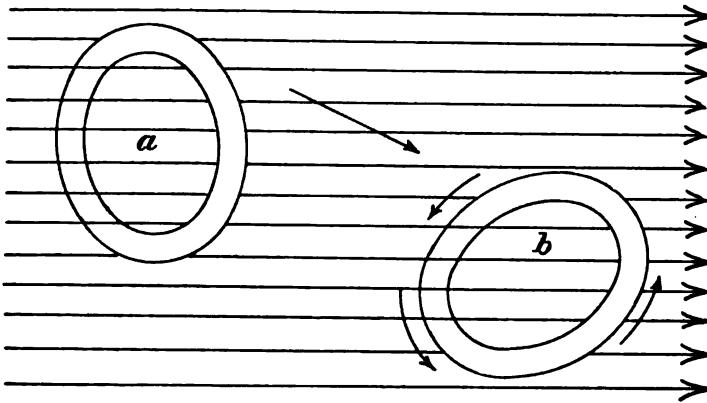


Fig. 36.—Lines of force changed by tilting the ring.

will be according to the following formula. The number of lines cut per second per turn of the coil is 100,000 times 100 or 10,000,000. The total number of lines cut by the coil of fifty turns is 10,000,000 times 50 which will induce a pressure of 500,000,000 divided by 10^8 or 5 volts.

A solenoid is a coil of wire and has north and south poles and possesses all the properties of a magnet. The current strength of a solenoid depends upon the number of turns of wire composing the coil. Its magnetizing power may be increased by inserting in the solenoid a bar of soft iron (iron core). When a magnet has reached its highest degree of magnetism it is said to be saturated.

Magnetomotive force is similar to electromotive force. When a coil passes around a core several times its magnetizing power is proportional both to the strength of the current and to the number of turns in the coil. The product of the current strength in amperes passing through the coil multiplied by the number of turns composing the coil is called *ampere turns*. One ampere turn will produce 1.25 plus units of magnetic pressure.

When magnetism in a magnet metal falls short of the magnetizing flux which produces it, it is said to be in *hysteresis*. Hysteresis is caused by the friction between the molecules of the magnetic material in changing their positions, which occurs in the process of magnetization and demagnetization. The loss of power during hysteresis is converted into heat.

When a mass of iron has once been magnetized it becomes difficult entirely to remove all the magnetism. The amount retained is known as *residual magnetism*. If it were not for residual magnetism a dynamo could not start a current without being excited from an outside force.

CHAPTER III.

METHODS OF OBTAINING AND ALTERING ELECTROMOTIVE FORCE.

Electromagnetic induction. Self-induction. Transformers. Motor-dynamo. Auto-transformers. How to construct a coil. Dynamo. Electrolysis. Ionization.

ELECTROMAGNETIC INDUCTION.

THE practice of electrotherapy has materially changed during the past few years. Twenty years ago our electrotherapeutic equipment consisted of a static machine, a galvanic battery with wall plate and a faradic coil. Since electricity has come to be an important asset in commercial activities many manufacturers have placed at our disposal many styles of apparatus with which we are enabled to appropriate to our use city lighting currents, therefore it behooves us to make acquaintance with electromagnetic induction.

If a body holding an electrical charge, or a conductor carrying an electrical current causes electrical phenomena, such as attraction or repulsion, to appear in neighboring bodies which are in no way connected with the electrified body or conductor, such phenomena are said to be produced by induction.

Induction, therefore, is an influence by which electrical phenomena are produced without contact. If a wire is brought near another wire (the latter carrying an electrical current) at once there will be an electrical current set up in the wire which is brought near it. This shows that the wire carrying the current is surrounded by

a field of influence which charges bodies of wire without there being any contact with the wire which carries the current. The influence which produces these phenomena is called induction. Charges or currents produced by induction are known as induced or secondary charges, induced or secondary currents.

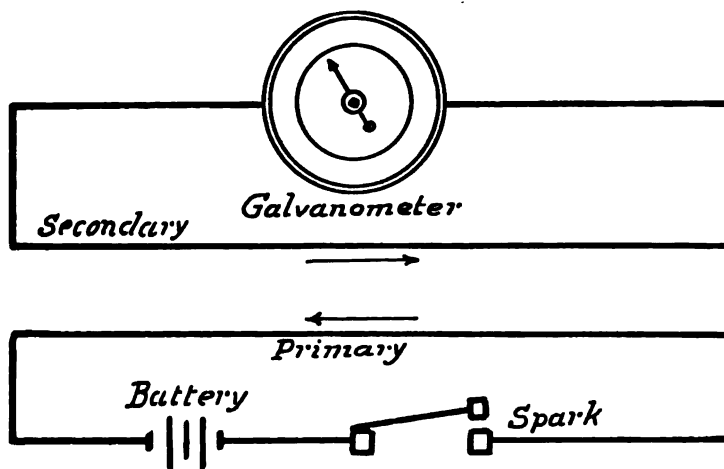


Fig. 37.—Induction.

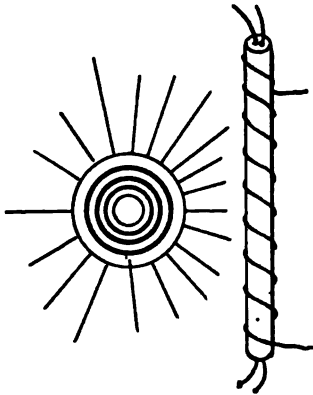
The diagram (Fig. 37) illustrates the action of mutual induction between two circuits, the one including the source of electrical energy and a switch; the other including a galvanometer but having no cell or other electrical source. During the increase or decrease in strength of current as on closing or opening the key, a current is induced in the secondary circuit in a direction opposite to that of the primary current as indicated by the arrows.

Fig. 38 gives the effects upon the core of a solenoid when brought into a magnetic field.

Fig. 39 is a diagram showing the direction of flow of current in the magnetic field of a charged wire.

The sphere of magnetic influence around a magnet is known as the magnetic field. If a magnetizable substance be brought within this magnetic field it will become magnetic. The influence producing this phenomenon is called magnetic induction.

Fig. 40 illustrates Lenz's law. If a copper ring be held in front of an ordinary electromagnet, and the current circulating through the coil of the magnet be in such



*When a magnet wire
Meets another wire
It does not need to try
It magnetizes the other
While it passes by*

Fig. 38.

a direction as to magnetize the core as indicated by the letters *SN*, then as the current increases in the coil more and more of the lines of force proceeding from *N* pass through the ring from left to right. While the field is thus increasing, currents will be induced in the copper ring in the direction indicated by the arrows, such currents tending to set up a field that would pass through the ring from right to left and would therefore retard the growth of the field due to the electromagnet *M*.

When an electrical body induces charges upon neighboring bodies the process is called *electro-static induction*. A magnet induces magnetism in other magnetic material

by the process of *magnetic induction*. A moving magnet induces electric currents in nearby conductors by the process of *electromagnetic induction*.

Magnetic induction was discovered by Faraday. He took a core of iron, insulated it perfectly and wound a coil of wire over the insulated core. He then covered the coil with an insulating substance and wound another wire

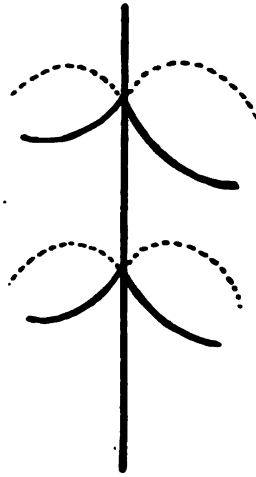


Fig. 39.

over this insulation. By allowing a current to pass through the wire covering the core, the core became magnetic and another current was set up in the outside wire. The current in the outside wire is known as the induced or secondary current. This is the principle of the faradic coil.

All dynamos of whatever form are based upon the discoveries of Faraday. Fig. 41 is an illustration of the first dynamo, made by Faraday in 1831. It consists of a horseshoe magnet and a copper disc attached to a shaft supported so as to turn freely.

The magnet is so placed that its interpolar lines of force traverse the disc from side to side. There are two copper brushes; one bears against the shaft and the other against the circumference of the disc. A handle serves to rotate the disc in the magnetic field. The induced current flows out at the brush on the circumference of the disc and returns through the brush at the shaft.

Electric currents are generated in conductors by moving them in a magnetic field so as to cut magnetic lines of force. A conductor cuts lines of force when it

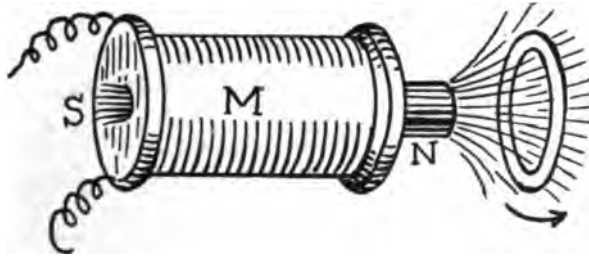


Fig. 40. Induction. The more lines cut the greater the force of the current in the ring.

moves across a magnetic field in such a manner as to alter the number of magnetic lines of force which are embraced within the circuit.

Figs. 42 to 46 illustrate the sine curve with a view of the armature for each 90° of the revolution, showing the application of the sine curve to the alternating current cycle.

Fig. 42 shows the loop of wire $A B C D$ in the vertical position at the beginning of the revolution. The electromotive force is at zero (see line below). As soon as the loop rotates out of the vertical plane the electromotive force rises and a current begins to flow in the direction indicated by the arrows, going out at M and

returning through the brush *S*. Continuing the rotation, the electromotive force increases in proportion to the sine of the angle made by the plane of the loop with the horizontal, until the loop comes into the horizontal position as seen in Fig. 43. This increase is indicated by the gradual rise of the sine curve. The loop has now made one quarter of a revolution and the electromotive force has reached its maximum (see sine wave below). As the loop rotates past the horizontal position (Fig. 43) the electromotive force gradually decreases, reaching the zero point at the end of the second quarter (Fig. 44).

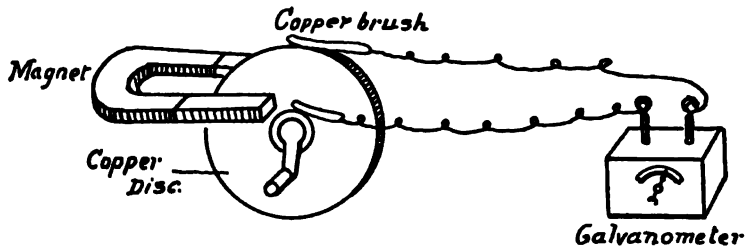
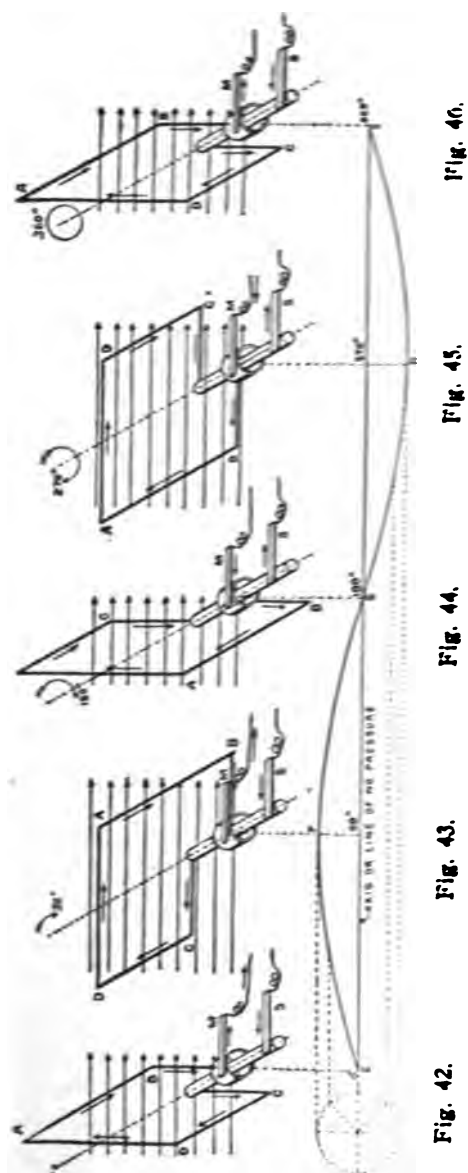


Fig. 41.—The first dynamo, Faraday, 1831.

When the loop turns out of the vertical position shown in Fig. 44, the current reverses; at this point the brush *M* becomes negative and *S* positive. In rotating through the last half of the circle, the current shows the same decline and rise as before, but it is reversed (see sine line below Figs. 45 and 46). The sine curve as above described represents a slow sinusoidal current.

SELF-INDUCTION.

Self-induction is the property of an electrical current by virtue of which *it tends to resist any change in its rate of flow*. It is possible to have induction effects without a second circuit, two parts of the same conductor or two different turns of the same coil on one another. The cur-



The sine curve. Armature position at each 90° of revolution.

rent arising in such a coil will act inductively on itself, tending to produce a reverse current, which effect will be shown in a retardation of the rise of the main current. This effect is called self-induction. Self-induction is sometimes referred to as *inertia* of electricity and is analogous to the mechanical inertia of matter.

The capacity which an electrical current has for producing induction within itself is called *inductance*. Inductance is considered as the ratio between the total induction through a circuit and the current producing it, and may be measured in terms of a unit called a *henry* or *millihenry*. The effect of inductance is to cause the current to lag behind. Self-induction manifests itself by giving a sort of kick or momentum to the current so that it cannot be instantly stopped when the current is broken, the result being a spark at the moment of breaking the current. In a single circuit consisting of a straight wire and a parallel return wire there is little or no self-induction.

Induction coils are employed chiefly for the direct application of currents of varying voltage, strength and frequency, and wave form to the patient as well as for supplying the high-frequency current. All medical induction coils are practically of similar construction, consisting of a primary and secondary coil in mutual induction relation to each other, a core made up of a bundle of soft iron wires and an interrupter to vary the frequency of the primary current. The number of wires in the primary and secondary coils, the voltage of the primary and the manner in which the mutual induction between the coils is varied depend entirely upon the purpose for which the coil is used. The value of the voltage induced in the secondary circuit depends upon the number of turns in the secondary coil and the frequency of the primary.

TRANSFORMERS.

A transformer is an apparatus similar to the induction coil, for the purpose of transforming alternating currents, usually of small quantity and high pressure, into currents of large quantity and low pressure. It consists of two coils of insulated wire wound adjacently upon a soft iron core—the primary coil of high resistance consisting of many turns of fine wire and connected to the high potential circuit; and the secondary coil, consisting of fewer turns of coarse wire and furnishing the current at a reduced pressure. This is a *step down* transformer. In a *step up* transformer the conditions are reversed, the primary winding being made of few turns of coarse wire and the secondary winding of many turns of fine wire (see Fig. 20).

The voltage of the secondary current is to the voltage of the primary current as the number of turns of the secondary winding is to the number of turns of the primary winding. For instance, if the voltage of the primary current be 10 volts, the primary winding have 10 turns and the secondary 100 turns, then the secondary voltage would be 10 times 10 or 100 volts.

The primary winding of a transformer is called the inducing coil; the secondary winding is called the induced coil. A coil of wire with an iron core used in an alternating current circuit to impede the current is called an inductance or *choke coil*.

If two separate coils of wire be wound on an iron bar, and a direct current be passed through one coil, no effect is produced in the other coil except at the moment of turning on the current; but if an alternating current be used instead, a current is at once produced and maintained in the second coil (see Fig. 20).

MOTOR-DYNAMO.

A motor-dynamo is a combination of dynamo and motor on the same shaft, one receiving a current and the other delivering a current. It can transform continuous currents up or down. Another form of motor-dynamo is called the continuous alternating transformer. This is arranged so as to change a continuous into an alternating current or the reverse. This is also called a rotary converter (Fig. 47).

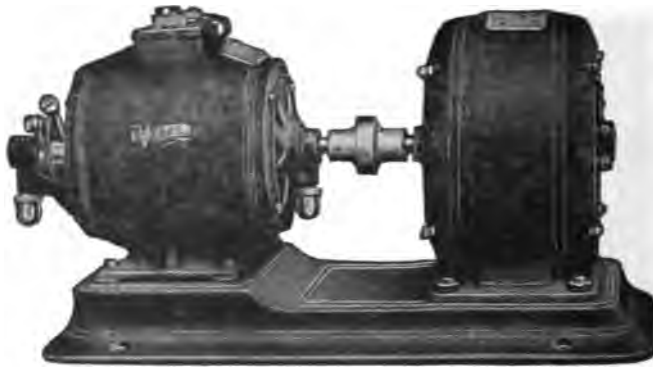


Fig. 47.—Direct connected generating set for transforming alternating to direct current. As will be apparent at a glance, this outfit consists of an alternating current motor attached by means of a coupling to a direct current generator, the alternating current operating the motor which in turn drives the generator which delivers direct current.

AN AUTO-TRANSFORMER.

An auto-transformer is a variable compensator in which a choking coil is introduced across the alternating current supply circuits so that varying currents can be obtained from different points on its windings. This device has been recently added to all first-class x-ray machines.

A Tesla transformer is a form of induction coil designed by Tesla for obtaining high potentials and frequencies. It consists of a primary of a few turns and a secondary of fine wire, both immersed in oil insulation.

Many physicians are using coils for different purposes without the knowledge of their construction. I believe it not out of place at this time to take up the several steps of construction of a simple coil.

HOW TO CONSTRUCT A PLAIN COIL.

Select a quantity of soft annealed iron wires (No. 20 B & S gauge) and construct a core about $\frac{3}{4}$ inch in diameter and 6 inches long. Over this core slip a spool made of insulating material on which wind several layers of No. 18 B & S gauge silk insulated magnet wire. Bring the ends of the wire through the heads of the spool and connect to binding posts affixed thereto; then apply a layer of insulating material over the primary wire. The wire for the secondary should consist of No. 36 B & S gauge silk covered magnet wire, the amount used or the number of turns made varying according to the amount of voltage desired. When a sufficient number of turns has been wound on, bring the ends out to a set of binding posts in the same manner as the primary, then soak the entire coil in shellac dissolved in alcohol and bake it or apply melted paraffin and allow it to cool, then place it in a hard wood box or shell of hard rubber. (The proportions of the coil may be varied to suit one's fancy.) Connect the secondary to fixed insulators and bend the ends so that they are about $\frac{1}{8}$ inch apart. Connect one end of the primary to a battery and brush, the other end of the primary against the other terminal of the battery. When the contact is broken there will be a spark at the point of break in the primary and at the air gap in the sec-

dary. The spark produced at the air gap occurs at the break of the current and not at the make, because, when the current is flowing it cannot stop instantly, due to the self-induction. This experiment teaches us that electricity possesses *inertia*, therefore is a *substance*.

The coil just described is a weak one and suitable only for ignition purposes, but if a vibrator and condenser be added you will have a Rhumkorff induction coil. The object of the vibrator is to rapidly make and break the primary circuit. The vibrator consists of a flat steel spring secured at one end, with the other free to vibrate. At a point about midway between the ends contact is made by means of an adjusting screw from which it springs away and returns in vibration. The points of contact of spring and screw are tipped with platinum. One wire of the primary is connected to the spring and the other to the screw, thus allowing make and break of the circuit.

The purpose of the condenser is to absorb the self-induced current of the primary and prevent the rapid fall of the primary current. The condenser may be constructed with a large number of sheets of tinfoil with sheets of paraffined paper between. Connect all sheets of tinfoil together at one side and all sheets of paper at the other. These connections form the terminals of the condenser. The condenser is connected across the break in the primary circuit. Every conductor of electricity forms a condenser and its capacity depends upon the extent of its surface.

The action of the vibrator is as follows: (1) The primary current magnetizes the core. The core attracts the vibrator which breaks the primary current. (2) The core loses its magnetism and the vibrator springs back to its original position. (3) The vibrator by returning to its

original position closes the primary circuit and the cycle begins again.

The vibrator just described is of the simplest construction, but the principle involved is that of all kinds of vibrators.

The sparking distance of induction coils in air may be stated as follows:—

Volts.	Distance in Inches.
5,000	$\frac{1}{8}$
10,000	$\frac{1}{2}$
20,000	1.
35,000	2.
60,000	$4\frac{1}{2}$
80,000	7.
130,000	13.
150,000	15.

In using a faradic coil on a wall plate or elsewhere do not use a high voltage current because it does not improve the spark but will burn out the contact points on the vibrator and run down the battery. The maker of a coil usually indicates it as a certain number of volts coil, and the voltage indicated should not be exceeded. The proper form of a faradic coil for therapeutic use will be mentioned later.

DYNAMO.

A dynamo is a machine constructed for the purpose of converting mechanical energy into electrical energy by electromagnetic induction. Strictly speaking, the word *dynamo* designates a machine which produces a direct current. The machine producing an alternating current is known as an *alternator*. The word *generator* is used to designate any machine that transforms mechanical energy into electrical energy by electromagnetic induction: the term includes both dynamo and alternator.

A dynamo does not create anything, but produces an induced electromotive force which causes a current of electricity to pass through a circuit of conductors. The electromotive force transferred by the dynamo causes a current of electricity to pass from a lower to a higher potential and from higher back to lower again in the external circuit.

Be it remembered that dynamos do not create electricity, but set in motion electrons already in existence by producing sufficient pressure to overcome the resistance to their movement.

From an electrotherapeutical standpoint it is thought to be unnecessary to go further into electrical mechanics.

ELECTROLYSIS.

This is a term applied to decomposition of a chemical compound in solution and resolving it into its constituent elements by passing through it an electric current. The constituent elements are called *ions*. An ion is composed of one or more atoms of an element, and, when set free, starts upon a wandering journey in the electrolyte. He is therefore a tramp. The tramps which turn up at the positive pole (anode) are called *anions* and those at the negative pole (cathode) *cations* or *kathions*.

The degree of electrolysis depends upon the strength of the electric current, and the current must be continuous or direct. If a current passes through a series of cells the same degree of electrolysis occurs in each cell of the series.

The mere contact of two dissimilar metals such as zinc and copper starts the movement of electrons, causing an electric current to pass from one to the other, proof of which is evidenced by the presence of copper on the zinc and zinc on the copper element.

The electrolytic effect upon water is one of decomposition, the hydrogen collecting at one pole and the oxygen at the other. A metal has a strong tendency to dissolve in a liquid during the passing of an electric current. The zinc of a primary cell during the passing of a current is gradually giving up particles to the electrolyte. When it is desired that no particles of metal pass into the electrolyte, platinum is used. While platinum ions may be set free they are not soluble in usual electrolytes. Platinum electrodes are used in electrotherapy when no phoretic action is contemplated.

During the process of electrolysis not all the ions reach the respective electrodes; a portion may remain in the electrolyte and form new associations. Decomposition and recombination are continually taking place in the electrolyte.

The importance of electrolysis in electrotherapeutics lies in the fact that the human tissues form an electrolyte. While it is probable that a certain amount of chemic change takes place in all the tissue traversed by the current, the effects are most marked at the points of contact of the electrodes where the products of electrolysis appear. The lesser effects between the electrodes are probably due to the wide diffusion of the current as well as the current coming in contact with membranes, tending to produce a series of electrolytic cells. Human tissues do not conduct a current of electricity in the same manner as do metal conductors. The human body may be regarded as a mass saturated with sodium chlorid and conducting a current by electrolysis. Electrons move over a copper wire at the rate of 180,000 miles per second, but they move through the human body at the rate of about 120 feet per second. The natural nerve conductivity of body currents is still less. Prick a toe of an

adult: the stimulus is conducted to the spinal cord by a sensory nerve. It is then transmitted to the motor cells in the anterior portion of the cord where it is converted into an impulse which is conducted to the muscle which contracts to remove the toe from the stimulus. The time required for the transmission to and from the cord is about $\frac{1}{8}$ of a second.

An electric current passing through the body causes a stream of sodium ions to move toward the cathode (negative) and a stream of chlorine ions toward the anode.

The products of electrolysis are liberated at the poles but do not consist of free sodium and free chlorine. The result is the liberation of free oxygen or acid at the anode and free hydrogen or alkali at the cathode.

IONIZATION.

If the electrodes be of metal, metallic ions will be set free at the anode and diffused into the tissues. This process is called *ionization*; it is also called anodal diffusion and *cataphoresis*. Metallic ionization serves many useful purposes in electrotherapy, as will be seen later on. When ionization is not desired, electrodes least affected by electrolytic action should be employed. Block tin and platinum yield very few ions and when used as electrodes or needles the result is one of dissociation of the tissues themselves with but little anodal diffusion.

The chemical effect of a negative electrode is the liberation of an alkali which has a dissolving action upon albuminoid substances, and when continued long enough will cause necrosis and a *soft scar*. The effect of the positive electrode is similar, but an acid is set free which causes coagulation, necrosis and an *unyielding scar*.

Care should be exercised in the use of long continued direct currents on the skin or mucous membranes on ac-

count of the acid and alkaline radicals being set free at the poles and producing severe chemical effects. These effects may be avoided by changing the polarity of the current, but if change of polarity be undesirable and long application necessary to secure results, employ a large pad or an electrode made of soft clay or asbestos.

Leduc illustrated the effects of electrolysis in a very striking manner by placing the anode moistened with a solution of strychnine sulphate on a rabbit and the cathode applied to another rabbit connected with rabbit No. 1 with wet gauze. When the current was turned on chlorin ions passed from the tissues to the anode and the strychnine passed into the rabbit which exhibited the classical symptoms of strychnia poisoning. Rabbit No. 2 was unaffected. Then he used a solution of potassium cyanide in the same manner, when the cyanogen ions collected at the cathode on rabbit No. 2, killing the animal.

In the administration of drugs by phoresis we must take into consideration the magnetic affinity for the positive pole, therefore, such substances as iodine, chlorin, bromine, which are electro-negative, pass into the tissues from the negative pole. Most metals and compounds of metals have an affinity for the negative pole, therefore such drugs as cocaine and morphine should be applied on the positive electrode. As a general rule acids and their equivalent in compounds should be placed on the negative pole and bases and organic compounds on the positive pole. Weak solutions, from one to four per cent, are more readily ionized than stronger ones.

The strength of current should always be regulated within the tolerance of the patient. The susceptibility of different skins to electric currents varies greatly. Some will complain of a current strength of 5 milliamperes while others will take a current strength of 20 milliam-

peres without complaint. It is better to be guided by the patient's tolerance than the readings of the milammeter.

The results from phoresis are better from a small amperage and a longer time than from heavy currents for a short time. The duration of the treatment depends upon the distance from the electrode to the point to be reached. It is simply a matter of mathematics: a deep nerve trunk like the sciatic will require a heavier current and longer time than a nerve like the facial, situated near the surface.

Do not confuse the terms *electrolysis* and *ionization*. In electrolysis we get an electro-chemic decomposition with the resulting ions from the tissues attracted toward the poles. In ionization, while we get more or less electrolysis at the poles, the object is to drive ions *from* the electrodes *into* the tissues. In other words, electrolysis is an electro-chemic action on the tissues from *within* while ionization means the introduction into the tissues of something from *without*.

From a medical standpoint we understand *phoresis* to be the process of diffusing medicinal substances into the body through the skin or mucous membranes by means of a direct current of electricity. The process of diffusion of substances into the tissues by means of the positive pole is known as cataphoresis or anodal diffusion, and that by means of the negative pole anaphoresis or cathodal diffusion.

Ionic medication includes electrolysis, ionization, cataphoresis, and anaphoresis.

CHAPTER IV.

ELECTROTHERAPEUTIC APPLICATION OF GALVANIC AND STATIC CURRENTS.

Galvanism. Electrodiagnosis. Shotgun therapy. Ionization. Ionization therapy. Ionization in gonorrhea and gynecology. Hypertrichosis. Faradism. Wall plate. Static electricity, its use in prostatitis, chronic neuritis, arthritis, muscular spasm, sprains, neuralgia, skin diseases, stiff joints, septic wounds, ulcers, sciatica, furuncles, etc. Types of static machine. Care of static machine.

GALVANISM.

GALVANISM is a term applied to a direct current of voltaic electricity. It received its name from Luige Galvani, an Italian physician. Galvani thought he had discovered electricity in animal matter, but Alessandro Volta, an Italian physicist, proposed a new theory of electricity at variance with the animal electricity doctrine of Galvani, suggesting that electric power resided in metals and operated when they were in contact. In 1800 Volta developed an electric pile which bears his name. He is recognized as the discoverer of current electricity, and in his honor the unit of electromotive force has been named the "volt."

Since the almost universal adoption of the motor-generator as a source of supply of electricity in electrotherapy, the word galvanism is being displaced by the terms "direct current," "constant current" and "unidirectional current."

A low voltage (40 to 80) is all that is needed in general work. Milliamperage from $\frac{1}{2}$ to 60 is also about the

limitations required. However, whenever we desire to use zinc mercuric ionization as employed by Massey, a milliamperage of 2500 may be required.

Physiology.—The effects of direct current upon the tissues of the body may be summed up as *chemical*, *thermic*, and *mechanical*. These effects will be found to vary with the voltage and amperage as well as the direction and density of the current. The principal effect is due to electrolysis which has been explained.

The effect upon the blood is to alter the relations of the hemoglobin with the balance of the cell.

A strong current applied to the body causes a movement of myelin of medullated nerve fibers.

The effect upon the muscles is to cause contraction. Different voluntary muscles may be made to contract on make and break of the current.

Cellular activity may be enhanced by proper application. Secretion of glands may be increased or diminished through the nerves regulating the blood supply as well as those regulating the functional activity of the cells themselves.

By proper application of electrodes an electrical current may be seen, heard, and tasted.

Current density is of considerable importance in the effects of electricity. It gradually becomes less as the distance from the electrode increases. The position of the electrodes influences the density of the current in passing through different organs, hence has a great deal to do with the physiological effects. The effects upon the different organs of the body, in many instances, may be more profound when the electrodes are applied over spinal vertebræ thereby influencing the vasomotor mechanism, than when applied directly over the organs themselves.

The effects upon the sympathetic nerves are very important: The movements of the viscera, glandular secretions and certain control of the blood-vessels are more or less under the control of the sympathetic nervous system. One set of fibers of the sympathetic may be irritated, causing a stimulation of the functions of glands,



Fig. 48.—Represents a very efficient apparatus for the production of direct, faradic, and sinusoidal currents. It is also equipped for vibratory massage, nasal drilling, heated air, pneumo-massage of tympanum, spraying liquids, nebulizing oils, powder blowing, etc. It is equipped also with a suction apparatus suitable for aspirating sinuses and induction of Bier's hyperemia.

while the irritation of other fibers will inhibit the function of the same gland.

The effects of a direct current upon the tissues of the body depend largely upon the voltage and amperage. A

high voltage is capable of sending a large amperage through the tissues, but does so only when a large quantity is on hand. Ordinary electrotherapeutic apparatus as a rule furnish small quantities of electricity. The effects upon the tissues are really due to a proper combination of voltage and amperage—in other words, upon the number of watts produced.

The galvanic current is an all-round useful agent in medicine. In small doses it has a soothing and toning effect. It increases metabolism and stimulates functional activity of the part through which it passes. The effects produced are not transient but continue for days after the application, so that the full benefits are not experienced for some time after its administration. Its tendency is toward restoration of impaired nerves and it actually relieves pain where nerve disfunction is present. It feeds the dormant nerve cell and starts it into activity thus making it of special importance in subacute and chronic conditions resulting from injuries when the healing process is delayed or when there is an excess of exudates forming scar tissue about nerves of the part causing neuralgia and neuritis.

When the current is employed for the purpose of ionization a large amperage is required, but when soothing effects are desired a low voltage and amperage should be employed. When a muscle shows the reaction of degeneration, the weakest rhythmic current possible to produce a contraction should be used. Normal muscle will not respond to a slow, weak rhythmic current that will produce a contraction of one showing the reaction of degeneration, in consequence of which an entire limb may be subjected to treatment by this current without stimulation of the normal muscles. This important fact should

not be overlooked in the treatment of a limb where only certain muscles or nerves are impaired.

ELECTRODIAGNOSIS.

A direct current turned on gradually must reach a very strong point to produce muscular contraction. However, a very weak current, if interrupted, will produce a very vigorous contraction. The contraction is produced by the variable period of the current and not by the constant period.

Monopolar stimulation is effected by placing one electrode upon the nerve or muscle while the other is placed upon some indifferent point. A muscle responds about equally well to positive or negative monopolar stimulation, but a nerve or motor point of a muscle shows considerable difference between positive and negative monopolar stimulation.

Muscular contraction produced by making and breaking the current with the anode and cathode monopolar application to motor points of muscles varies in the following order: The weakest current able to produce a contraction is on cathodal closing. Next stronger are anodal opening and anodal closing which are about equal, and strongest of all cathodal opening. The cathodal opening contraction usually requires a current of such strength as to cause considerable pain.

In applying the same strength of current to a normal muscle the strongest contraction will occur on cathodal opening. For practical purposes in electrodiagnosis it will be necessary only to employ the methods of cathodal closing and anodal opening.

Electricity is employed as an aid in diagnosis to distinguish between feigned and real disease; to distinguish

between different forms of paralysis and sometimes to distinguish between apparent and real death.

The tests applied to distinguish between feigned and real disease are in many instances of considerable importance, as are also the tests for different forms of paralysis. My respect for the reaction of degeneration has received many shocks during the past few years. Often we get the reaction of degeneration and a few weeks later, to our surprise, the dead muscles will react upon application of a faradic current. My rule is not to abandon a muscle until after one year, and sometimes even that is too early.

It is important to know that voluntary motion returns sooner than electrical reactions after a nerve injury. The return of faradic excitability without return of voluntary movement is very good proof of malingering.

Prognosis.—In cases of peripheral paralysis with normal electrical reactions, recovery may be expected in three weeks. If the reaction shows hypoexcitability recovery will be delayed from two to four months, with a reaction of degeneration. In such a case recovery is problematical; the duration of the paralysis will extend six months or more and is sometimes permanent.

In cases of rapid muscular atrophy very little improvement is to be expected. The rapidity of the loss of electrical reaction will give a good idea of prognosis. If in an acute lesion the loss of faradic excitability occurs within a few days considerable atrophy will follow. If it is lost in three weeks the paralysis will last many months but there will be less atrophy.

SHOTGUN THERAPY.

The old-time labile application of a direct current has been practically abandoned. In late years we have learned to apply any electric modality with a definite idea

of producing a definite effect. Labile application of a direct current embodies the same idea as a shotgun prescription in drug-therapy from which we sometimes got results (just how could never be explained), whereas in shotgun electrical application we often produce results just the opposite of those intended. The application of electricity in any form labile to the spine will excite reflexes opposite in effect; so if we do no harm we at least do no good. In the application of any form of electricity, have a definite idea of the effects desired and use the mode in accordance with definitely known principles.

The empirical use of electricity in therapy in the past has brought it into disrepute, and we often hear such remarks as "I have tried electricity and there is nothing in it." It is invariably true that he who has tried it and found it wanting has been operating on the shotgun principle, applying where it is not indicated or using the wrong modality.

It is painful to observe some who ought to know better, employing in a haphazard manner, an agent so potent for good, with no more of an idea of its effects than Mary D——, who once came into my office and demanded that I give her a "*shock*" to restore her menstrual function. It is needless to say that I was the only one who received a shock.

Some specialists in diseases of the nervous system have worked out a technic of electrodiagnosis satisfactory to themselves, while others work in such a listless manner that it is obvious that they need a training in the elementary branches of electrotherapy. Do not understand me as berating empiricism in medicine, for it is through it that many efficient therapeutical results have been obtained. Empiricism is practical in all walks of life and is the father of nearly all discoveries. We have

never attained much knowledge except through painstaking trial, but when we have arrived at a point of physiological attainment in the action of electrical modalities let us not turn the hands of knowledge backward.

The practical uses of a direct current in therapeutics resolve themselves into the effects of *electrolysis* and *ionization*.

IONIZATION.

It is known that when a salt is dissolved in water that a more or less separation of its basic radical from its acid radical takes place. For example, the salt, zinc sulphate, ZnSO_4 , the basic radical of which is zinc, Zn, separates from the acid radical, SO_4 . In a simple solution complete separation does not take place but if a continuous electric current of sufficient electromotive force be passed through the solution, many basic radicals will seek the negative and many acid radicals the positive pole, but a complete separation is not effected; sulphate of zinc as a salt still remains in solution. The minute particles of the acid as well as the base have been designated *ions* each of which exhibits an attraction for one or the other pole. We have been taught that like poles repel and unlike poles attract, consequently we expect the negative radical to seek the positive and the positive radical the negative pole.

To my mind is suggested that the old theory of an ion being a radical plus an electrical charge will admit of discussion if not modification.

The fundamental basis of matter is now conceded to be an *electron* which consists of an electrical charge and its direction of movement is due to its potential in relation to its surroundings, but as potential means stress, an excess potential takes the positive or plus sign and a state

of less stress takes the negative or minus sign. It is quite probable that the atoms of the acid contain a less number of electrons than the basic atoms and that when an outside disturbing influence such as electrical stress is brought to bear the electrons are freed from the atom and seek the point of low stress or potential. The acid atom becomes surcharged or raised in potential and takes its place at what we have learned to call the positive pole. The basic atom which is already in high potential loses its surcharge or potential and takes its place at the negative pole. This is possibly an explanation which does not explain, it being a theory of my own[•] and is only given as food for thought.

As the acid radical seeks the positive and the basic radical the negative pole, it is possible through the application of an electrical current to so influence the movement of ions that they may become of service in correcting certain pathological conditions.

The process of breaking up an electrolyte into ions is called *electrolysis* and the separation of the ions, or the product of electrolysis is called *ionization*, but when ionic medication is spoken of, it means the movement of ions into the tissues from without. Strictly speaking, ionization takes place in the tissues whenever a continuous current is passed through them, but when no effort is made to introduce into the tissues a substance from without, the term electrolysis is used.

Ions introduced into the tissues from without may combine with the ions of the tissues and form new compounds. If the new compound is insoluble it is precipitated at once; if soluble it is quickly taken up by the circulation. Whether the ions of salicyl, iodine and chlorin are or are not carried by the circulation to remote parts of the body and there exert their physiological effects is

a debatable question. However, we know it is possible to push ions of various metals into the tissues of the body by means of a continuous current, the depth of penetration depending upon the condition of the tissues, the power of the current and time employed. The penetration is at the most but few millimeters.

Drugs are given internally with the idea of their ions reaching the diseased tissue consequently any drug, before it can be appropriated by the tissues, must become ionized. Suppose that a dose of 1 grain of a drug is given internally to a man weighing 150 pounds and that the drug be equally distributed throughout his tissues, each grain of his substance would appropriate less than 1 millionth part of a grain of the drug. In ionic medication the actual quantity introduced is very small, but when applied directly to the part, the amount appropriated as compared with its internal administration, is exceedingly large.

If there is any science in the application of drugs to diseased conditions, it is found in ionization.

A fluid which holds salts in solution is called an electrolyte. The tissues of the human body hold sodium chlorid in solution, hence they are excellent electrolytes. When a continuous current of electricity is applied to the tissues electrolysis and ionization take place. When salts of copper, zinc, and sodium become ionized the basic radicals in passing through the tissues become very irritating and in order to reduce the irritation to a minimum, the solutions are made isotonic by the addition of glycerin.

The following formulas for isotonic solutions are recommended by Dr. A. R. Friel:—

ZINC SOLUTION.

℞ Zinc sulphat.	75 grains.
Glycerin	2 oz.
Water	35 oz.

Sig.: Dilute with an equal quantity of warm water at the time of using.

SODIUM SALICYLATE SOLUTION.

℞ Sodium salicylate	175 grains.
Water	1 pint.

Sig.: Dilute with equal quantity of warm water just before using.

SODIUM CHLORID SOLUTION.

℞ Sodium chlorid	175 grains.
Water	1 pint.

Sig.: Dilute with equal quantity of warm water just before using.

ZINC GELATIN.

℞ Zinc sulphat.	8.75 grains.
Gelatin	65 grains.
Water	1 oz.

The gelatin may be prepared and kept in tubes. The contents may be liquefied just before using by immersing the tubes in warm water.

IONIZATION THERAPY.

Almost every chronic disease has been assaulted and insulted by galvanism and faradism, yet out of it all have been saved many choice kernels of therapy, and an abundance of chaff has been scattered by the winds of experience. There is nothing in the whole domain of medicine that will give such brilliant results as evidenced by electrolysis and ionization in selected cases.

We have already mentioned the enormous resistance offered by the human skin to electrical currents. Many a failure in securing beneficial effects of ionization has

been due to an inefficient preparation of the skin. The skin was so designed as to afford a protection to the delicate organs beneath from onslaughts of all kinds, and especially those of the ever-present electrons.

In order to secure any results of ionization through the skin a thorough cleansing is absolutely necessary. The use of hot water and soap followed by ether or alcohol and clean water is the proper procedure of cleansing the skin, and without this preliminary preparation penetration of ions cannot be expected. If there be abrasions they should be covered with collodion or adhesive plaster. Have a definite idea of what you wish to do and then do it with all your might. While it is necessary to keep an eye on the millimeter, it is better to have an eye and ear on your patient. Every patient is not a *case* but an *individual*, and success depends largely upon the recognition of this fact.

In going over the subject of ionization previously, it was stated that the first step in ionization was one of electrolysis and that compounds were broken up into their respective ions. There is considerable evidence to show that a complete separation does not always take place: taking for example, cocaine which is driven into the tissues as cocaine, or, at least, we get the same effect cathodically as we do hypodermically. A solution of adrenalin when driven in by the positive pole will, so far as we know, blanch the tissues identically as when injected with a hypodermic syringe. There is this difference: The diffusion is limited to the area covered by the electrode and the effects are more prolonged when used cathodically than when administered hypodermically.

Practically there are but three metals, copper, zinc, and mercury employed in ionic medication: all others are compounds. Drugs that do not undergo dissociation

in solution, such as ether, chloroform, chloral, phenol, and camphor, cannot be administered ionically, despite the adverse theory on the part of some electrotherapists. The drugs, sodium chlorid, sodium salicylate, potassium iodide, magnesium sulphate, salts of silver, adrenalin, and the alkaloids, in addition to the metals, zinc, copper, and mercury, are about the only ones employed in ionic medication. The late war has produced a long list of disabilities such as stiff muscles, stiff joints, and cicatricial formations of all kinds, all of which are amenable to ionic medication.

Shell fragment wounds, where there has been extensive damage done, present conditions varying from slight induration to extreme fibrosis. The contractions produced by scar tissue pinch the nerves, causing neuralgia and neuritis.

Ionic medication will do wonders for these sufferers. The three drugs, potassium iodide, sodium chlorid, and sodium salicylate, will be found useful in these conditions. Large pads should always be used. A large pad soaked in a 1 or 2 per cent. solution of potassium iodide is applied to the affected area over which is placed the negative electrode. The positive electrode should be a large well moistened pad and placed in the neighborhood of the active (negative) electrode, not so near, however, as to lose the penetration of iodine ions. If the part to be treated be on a limb, the position of the inactive (positive) electrode is best placed on the opposite side of the limb. If the affected part be on the body, place the inactive electrode on the same side as the active electrode and about 6 inches distant.

A comparatively strong current of 40 to 80 milliamperes for a long time is necessary. Strong currents are comfortably borne when large pads are used. All skin

abrasions and pimples must be covered with collodion or adhesive. Heating the parts by means of radiant light or diathermy before ionization will enhance its effect. In case toxic substances exist sodium salicylate may do better than potassium iodide. In hard unyielding scars the softening effects of sodium chlorid will be found to be advantageous. Care should be exercised in making these applications over wounds recently healed, where scar tissue should not be removed.

The stimulating effects of the high-frequency current from a vacuum electrode applied to the spinal nutrition centers will assist in restoring the nervous phenomena which are usually co-existent in these cases.

Ionic medication by sodium chlorid will clean up septic wounds in a few treatments. Old indolent ulcers will yield to zinc ionization in a few days when the stimulating effects of high-frequency vacuum application will close the ulcer.

The advantages of chlorin ionization treatment of foul infected wounds are that the odor disappears after one or two treatments and the resulting scar is soft and yielding.

In cases of stiff joints when passive motion is required, a preliminary application of diathermy will have an analgesic and antispasmodic influence upon the muscles.

IONIZATION IN GONORRHEA.

Dr. Charles Russ of London has proven that the germs of gonorrhea in salt solution collect at the positive pole. His treatment for this disease is as follows: A platinized canula perforated with small holes is inserted into the urethra down to the compressor urethræ and filled with a 2 per cent. sodium iodid solution plus iodine sufficient

to change the color to that of cherry wine. A platinum stylet is inserted in the canula; this is attached to the positive pole and the current of 1 to 3 milliamperes turned on. After five to ten minutes the current is reversed for about the same length of time.

He claims good results, although the principles of ionization are reversed. Chemically he gets a collection of ions of iodine and chlorin on the positive electrode and a penetration of ions of sodium. On reversal of current the iodine and chlorin are driven into the tissues. For many years I have employed cupric ionization in cases of chronic gonorrhea, the technic of which is as follows: Insert in the urethra a common rubber catheter perforated with many small holes and into which is inserted a stylet of copper upon which is wound absorbent cotton. The cotton is saturated with a 2 per cent. solution of copper sulphate. The stylet is connected to the positive pole and a current of 5 to 10 milliamperes turned on for five to ten minutes. I have never used this method in acute gonorrhea cases except in the female. In cases where the infection is limited to the area under treatment, the results are a prompt relief of the trouble. Further consideration will be given this subject later on.

IONIZATION IN GYNECOLOGY.

Some of the diseases of the uterus and its appendages are so closely associated that it is impossible for the gynecologist to make a diagnosis without an operation or an autopsy.

One of the consolations of the electrotherapist lies in the fact that curative results are frequently achieved without regard to mistakes in diagnosis and without any attempt being made to classify the lesions in terms. We

may properly select from the various electric modalities, in accordance with the indications, and cure the patient while the expert diagnosticians are still in controversy over the diagnosis.

The treatment of these cases by electricity includes nearly all, from cervical stenosis to inflammatory exudations that completely fix all the organs of the pelvis. There is no disease of the pelvic organs of women that cannot be alleviated or cured by electrification. The growth of fibroids can be stopped and the patient allowed to enjoy comfort for many years.

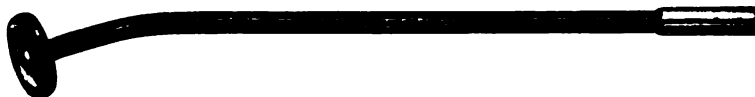


Fig. 49.—Fitz-Hugh's copper electrode for treating erosions of the external os by cupric ionization.

We all have many cases of cervical erosion, endocervicitis, metritis, endometritis, etc., and have made topical applications of almost everything mentioned in the pharmacopeia, having, no doubt, done some good, but I have no hesitation in saying that we can accomplish more with four treatments with some form of electricity than with forty of any kind of topical application. Topical applications relieve, but electricity cures. In gynecology the knife is sometimes necessary, but many women are unsexed when they could be restored to health by proper application of electric currents.

The ions of iodine are especially suitable in deep-seated inflammatory conditions. Silver ions are very useful in endometritis, vaginitis, and urethritis. For intrauterine treatment ions of copper and zinc are invaluable.

The cause of more pelvic disorders of women can be laid at the threshold of the gonococcus than to any other, or, perhaps, all others combined. There are but two conditions which we find in gynecological practice where some form of electrolysis or ionization has not proven its usefulness, those conditions being *pus tubes* and *cystic ovaries*. Both these conditions demand the services of a surgeon.

I am partial to the ions of copper in all cases of endometritis. With the positive pole of pure copper within

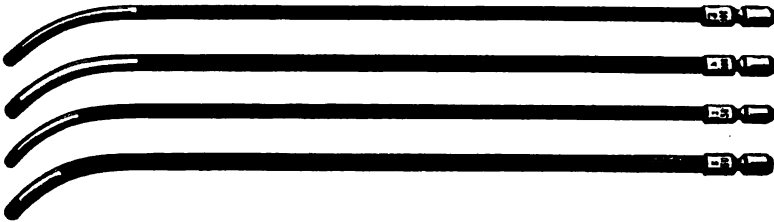


Fig. 50.—Neiswanger's copper intra-uterine electrodes, insulated tip and stem.

the uterus and the indifferent negative electrode of large size and well moistened on the abdomen or under the sacrum, and a direct current of 30 to 70 ma. for twenty minutes, results more or less marvelous will be secured. The tip of the electrode should, for obvious reasons, be insulated (Fig. 50). The current should be turned on gradually to the height of tolerance, and if the abdominal electrode be of proper construction and properly applied there will be no difficulty experienced from a current strength of 75 or more milliamperes. The treatments are given from four to seven days apart. If light currents are used (25 to 30 milliamperes), the interval between treatments may be as short as four days. When heavier currents are employed a longer interval is advised. If the septic condition does

not clear up in six or eight treatments the more penetrating ions of zinc or iodine may be used with advantage.

If upon attempting to remove the electrode from the uterus after ionization it is found to be adherent, a gentle rotary pull will usually be sufficient to remove it with the inflammatory products adhering thereto. In case the



Fig. 51.—Goldspohn's vaginal electrode, copper ball on insulated stem.

electrode adheres too strongly to be removed by gentle traction, a reversal of the current will loosen it sufficiently to be withdrawn.

A perfect insulation of the vaginal portion of the electrode must be secured before the current is turned on.



Fig. 52.—Goelet's intra-uterine negative dilating electrode, nickel plated, set of three electrodes with one staff.

In nearly all inflammatory conditions in and about the uterus it is advisable to employ mercuric ionization. This may be done with a copper ball electrode freshly amalgamated and covered with well-moistened cotton and applied in the vaginal fornix. Heavy currents (60 to 80 ma.) are required. Doubtless it is unnecessary to mention that the application should be preceded by a thorough cleansing of the vagina.

Stenosis of os and cervical canal may be relieved by the softening effects of negative electrolysis through a properly shaped electrode. In some cases the external os appears to be normal when a constriction exists at the internal os, when there may or may not be a sharp flexion. The technic employed in these conditions is as follows:

The positive electrode is applied to the abdomen. A speculum is introduced, bringing the os into view. A small olive-shaped electrode is introduced into the canal and a current of 3 to 5 milliamperes turned on. No force should



Fig. 53.—Dr. White's uterine elevator electrode. This electrode when applied in connection with either a slow sinusoidal current or an intermittent rapid sinusoidal current is a most valuable means of restoring prolapsed uteri and other forms of uterine mal-position to normal poise. If the indifferent pad is placed over the second lumbar vertebra, the results will be better than if over the abdomen. The metal part is a solid aluminum casting, finely polished, while the insulated portion is hard rubber. It can be attached to the ordinary universal wooden handle.

be exercised—just enough pressure to keep the electrode firmly against the stricture being all that is required. In case of pin hole os, and the smallest olive electrode will not enter readily after a contact for five minutes, a pointed electrode may be used.

A milliamperage exceeding five is not advisable. A heavy current will often cauterize the tissues and increase the stenosis. It has been my misfortune to see a few cases of this kind produced by incompetent hands. The

surgeon in whose hands such cases fall is almost sure to mention the ill effects of electricity.

In cases of undeveloped or infantile uteri the electrolytic treatment just mentioned should be followed with the sinusoidal current, which will develop the musculature of the uterus, in time, to practically a normal condition.

Multiple flat warts which often occur on the hands of young people can be successfully removed by one application of ionization of magnesium sulphate. The treatment of moles and birthmarks by electrolysis has been succeeded by desiccation.

HYPERTRICHOSIS.

Superfluous hairs are easily removed by negative electrolysis in the following manner: Let the patient hold the well-moistened positive electrode in the hand. A bulbous pointed steel needle is inserted into the hair follicle at the side of the hair for about $\frac{1}{8}$ of an inch; a current of $\frac{1}{2}$ to 1 milliampere is turned on. As soon as a bubble of gas appears the hair will loosen and can be easily removed. The treatment is followed by an inflammatory reaction, so it is advisable not to remove too many from one area at a sitting.

It is not my object to overload your minds with what *may* be done with a direct current in electrotherapy. It is my purpose only to consider the treatment by direct current where it is, in my opinion, the best electric modality to be employed. There is nothing that so injures a good thing as to tell half the truth about it. It is time that the truth be told about electrotherapy. When other therapeutic measures or surgery are better for the interests of the patient why bother with a makeshift? Electrotherapy is one of the helpmates in therapeutics and should not be looked upon in any other manner.

The technic of the removal of urethral strictures by electrolysis will be explained later.

In some cases of arthritis ionization of chlorin ions is very useful. Use as large pads as the circumstances will permit, one on either side of the joint and well moistened with a 2 per cent. solution of common salt. Employ a current as heavy as the patient will tolerate.

In muscular atrophy, after responses to a slowly interrupted faradic current have ceased, the cathode of a

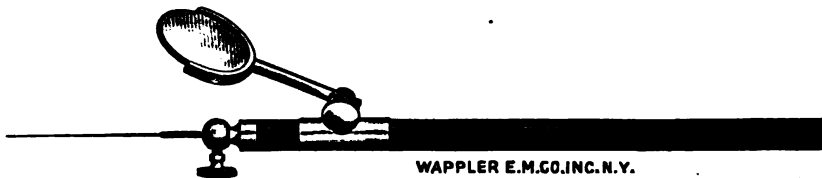


Fig. 54.—Electrode for removal of superfluous hair.

direct current may be employed with slow interruptions—20 milliamperes three times a week.

Some fissures and fistulæ in ano may be closed by ionization of copper. If it is possible to reach the entire fistulous tract with a copper wire electrode success may be assured. Insert electrode of pure copper wire to full length of fistulous tract, attach to positive pole (with negative at some indifferent point) and gradually turn on current of 10 to 15 milliamperes for five to ten minutes. If electrode cannot be removed by gentle traction, reverse the current until it is loosened. I have treated fistulæ which were tuberculous by this method and was signally successful.

The direct current is sometimes very useful in neuralgia. Application of the positive pole over the point of nerve compression is useful in allaying the pain, but

If the cause be an inflammation evacuate the positive pole and to hasten by increasing the ionization.

The negative pole applied over the closed eyelid and the positive over the cervical vertebrae with 2 to 4 milliamperes of current have proved of great value during the first stage of cataract.

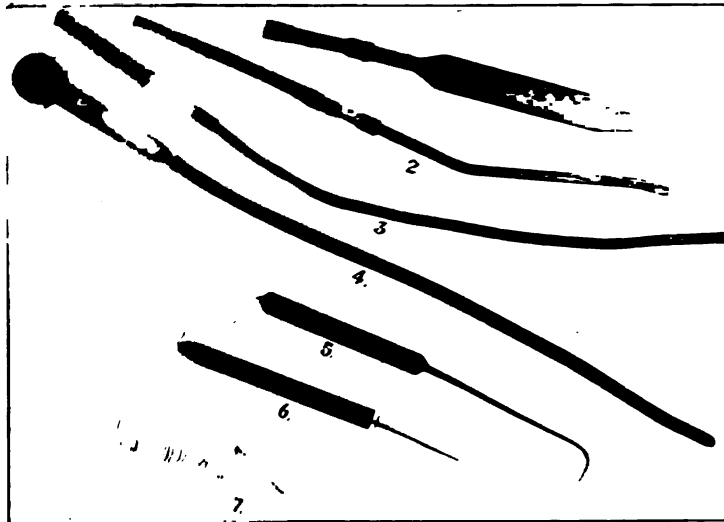


Fig. 55. Ionization electrodes. No. 1. For abscess with small opening. No. 2. For deep abscess. No. 3. For tortuous abscess and male urethra. No. 4. For posterior urethra. No. 5. Solid zinc for diseased tonsils and fistulae. No. 6. Solid zinc needle. No. 7. For middle ear infection.

That the direct current in electrotherapy may be employed with more or less benefit in cases not mentioned is appreciated, but the writer is unable to recall an instance not considered, where some other modality is not to be preferred.

Any of the illustrated electrodes (Fig. 55) may be made in a few minutes by the physician from material in his office.

No. 1 is made from a glass irrigating nozzle in which is placed a coil of wire. A No. 30 insulated wire is attached to the coil within the glass and brought out at the proximal end of the nozzle where it is bent over and downward leaving the free end to be attached to the positive pole of the battery. The rubber tube of the irrigator is then slipped over the bent wire and end of glass as shown in the illustration.

No. 2 consists of a female glass catheter within which is placed a coil of wire and connected in the same manner as in No. 1.

No. 3 consists of a soft rubber catheter in which several holes are cut along its entire length. A coil of wire is placed within the catheter to $\frac{1}{2}$ inch of the distal end. A No. 30 wire is attached to the coil within the catheter and brought out through the side of the rubber connection.

No. 4 consists of a coil of wire within a soft rubber catheter in which several holes are cut for a distance of 2 inches in the distal end. A 2-ounce urethral syringe and small gauge wire complete the electrode.

Nos. 5 and 6 consist of a strip of zinc passed through a glass tube with a cork at each end and insulated with sealing wax.

No. 7 consists of a horn or hard rubber ear speculum and coil of wire. The coil is wrapped with cotton and inserted into the speculum, allowing a twist of cotton to protrude far enough to reach the tympanum. The speculum is kept full of ionizing solution during the treatment.

These electrodes should be so constructed that the end of the wire within the tube cannot come in contact with the tissues during treatment, as it might produce an unpleasant burn.

FARADISM.

Many years ago faradism was used to relieve pain through its tetanizing effect upon muscles. This procedure is inadvisable because it enfeebles the muscles and may cause muscular atrophy. Outside of its use in electro-diagnosis faradism is only employed to restore enfeebled muscles.



Fig. 56.—The Bristow coil.

Manufacturers of faradic coils for electrotherapeutic use have in the past vied with each other to see who could produce a coil with the greatest number of miles of wire in the secondary and insisted upon the great advantages of this type.

The beneficial effects of faradism in restoring atrophied muscles of the injured during the recent war has

again brought to the front the employment of this modality.

Through its use in the military hospitals it was soon learned that high-tension coils produced an uncalled-for amount of pain, due to high voltage of the secondary; and through this understanding of the effects of high tension currents came an apparatus provided with a long coarse wire primary with many turns, and a secondary winding of the same size wire with but about one-half the number of turns of the primary, thus developing a low voltage and a high amperage—this being the principle of a stepdown transformer.

A current of this nature is especially adapted to producing muscular contraction with considerable force without producing pain. This type of faradic apparatus is now manufactured by the McIntosh Battery and Optical Company and is known as the Bristow Coil (Fig. 56). The principle of this coil is ideal and the benefits secured so satisfactory that I am impelled to recommend it most favorably.

The effects of combined galvanic and faradic currents are more fanciful than real. The more simplified the apparatus for the delivery of direct, interrupted and sinusoidal currents the better the apparatus.

WALL PLATE.

A wall plate or an apparatus for the purpose of delivering a direct current must be supplied from a direct current source. A battery of primary cells, a direct current supply or a motor generating set is essential. A chemical rectifier is unsatisfactory. An efficient apparatus must contain a dead-beat milammeter, a good controlling rheostat, a pole changer and an interrupting device called a rheatome. The faradic coil usually supplied should be

displaced by one made on the principle of the stepdown transformer. I see no objection to the addition of a sinusoidal device to the specifications just mentioned.

It has been my experience in attending lectures on electrotherapy that the teacher would not advise the student in the purchase of electrotherapeutic apparatus. My belief is that a student in electrotherapy is entitled to this information. I have expended thousands of dollars because of the want of this information. I have traveled the rough and rugged road of electrotherapeutic apparatus and it is my desire that the reader travel a smoother one, and have the benefit of my experience.

STATIC ELECTRICITY.

In the late nineties, soon after the discovery of the Röntgen ray, manufacturers of electric modalities caused a wave of enthusiasm to spread over the country by publishing the information that x-rays could be produced from the high voltage static machine. They did not overlook the real and imaginary therapeutic effects of the static current. The propaganda of these manufacturers caused many physicians to purchase these machines. The static machine was soon displaced by a coil for x-ray purposes, leaving thousands of machines in the hands of men who had no knowledge of their value in therapeutics and much less of how to operate them.

After applying the crown breeze a few times and securing no results, the machines soon became idle and in a few months were stored in the basement, attic, or consigned to the junk heap. It is not hard to explain why many physicians became prejudiced against the static machine. There is no electric modality that requires as much "know how" in its operation as the static machine,

and no other modality that is more capable of producing results.

When a physician once learns the benefits to be derived from the static machine and learns how to operate it, he clings to it tenaciously. Were I limited to one electric modality in my work I should by all means choose the static machine because there is no other modality capable of so wide an application in electrotherapeutic work.

It is true that there are many difficulties to surmount in practice with the static machine, but any physician with a little perseverance and attention to details can overcome the obstacles and prove to his entire satisfaction that it is invaluable in practice. Not unlike other electric modalities, it must be understood to be appreciated. No other agent can compare with it in usefulness in a wide range of affections. It is easily applied and pleasant to the patient.

The first electrotherapeutic application of an electrical current to the human body was from a static machine. It is the oldest, most abused and highly praised electric modality in existence.

Static electricity was so designated because it was found to exist upon the surface of all insulated bodies. The word *static*, meaning "at rest," as applied to this current of high potential is an unfortunate one, for it is the most active of all electrical currents in its discharge through air and other dielectrics.

The difference between static currents and other high potential currents is due to the different methods of production. The static current is of high voltage and low amperage; the current is unidirectional. We can hardly call it a direct or constant current because it is evidenced in charges and discharges. It is a unidirectional pulsa-

tory current. The old theory of static currents being conducted by the skin on surface of the body and having no penetrative power has been exploded by most painstaking experiments. There is no longer a doubt of the passage of the current through the body. Static electricity escapes by conduction, convection or disruptive discharge.

When the current is discharged from the human body it produces molecular atomic and electrotomic effects. The effects upon the human body by static current may be summed up as *mechanical*, *chemic* and *thermic*.

A person connected with one pole of a static machine does not remain charged with electricity unless the person be insulated. The current is unidirectional, and contact with the earth prevents its accumulation as an electric charge.

The positive pole of a static current counteracts hyperemia, relieves pain due to congestion and soothes nervous irritability. It is sedative and analgesic. The negative pole of a static current is a stimulant, excitant and irritant. It produces hyperemia and increases nervous irritability.

Static electricity contracts muscles and relieves muscular spasm. The contractions are induced from within outward to the place of discharge. The longer the spark-gap and the larger the terminals, the greater the volume and voltage of the discharge.

The static wave current accelerates repair by increase of metabolism; it increases glandular activity and promotes absorption. By its pulsatory character it drains engorged tissue and expresses the infiltrate of a hardened mass. It increases phagocytosis, thereby relieving infectious inflammations. No other agent is so active in restoring the functions of faulty metabolism. The passage

of electrons through the tissues equalizes their tone and assists in restoring their normal vibration.

Treatment of Prostatitis—Through all the ages since the animal man began to walk on his hind legs he has been afflicted with diseases of the prostate gland. It is estimated that 60 per cent. of all men who have attained the age of 60 years possess abnormal prostates. I have treated over 800 cases of diseased prostates with the static wave current with 60 per cent. favorable results. There is not a therapeutic measure known to the profession that will so effectually clear the seminal vesicles and prostate



Fig. 57.—Dr. Rice's improved copper rectal electrode.

of gonorrheal infection as the static wave current properly applied.

The technic of employing the agent is as follows: Place the patient on an insulated platform after inserting in the rectum and resting against the prostate gland an L-shaped copper electrode (Fig. 57). The patient is seated preferably on a hard-bottom chair; the stem of the electrode resting on the chair bottom assists in holding the electrode against the gland. Connect the electrode with the positive prime conductor of the static machine, the negative being grounded to a steam, gas or water pipe. Start the machine with the ends of the discharging rods close together, with the Leyden jars in the circuit. Gradually widen the spark-gap until the point of comfort-

able tolerance is reached. In acute cases the spark-gap should be short. Later on the gap is widened *secundem artem*. The best work will be done with a spark-gap so arranged as to obtain 100 to 200 pulsations per minute. Very rapid pulsations will relieve pain, but to secure drainage, slow pulsations are required.

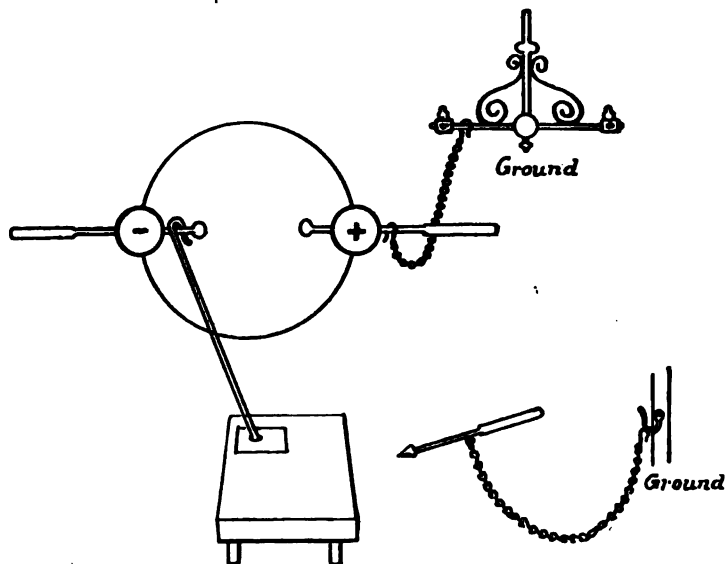


Fig. 58.—Blue pencil indirect.

In a large percentage of cases of prostatitis caused by the gonococcus, urethral stricture exists as a complication. The stricture should be treated by electrolysis. Cystitis is also present in many cases, and when present should be treated by bladder irrigations. The administration of hexamethylenetetramine is advisable unless found too irritating.

If the urine be alkaline in reaction it is advisable to prescribe benzoic acid for a few days. Atropine will be found useful in many cases.

In simple inflammations the static current will be found to be of signal service. Many cases of chronic neuritis yield to a few treatments by the static current. The static brush discharge and the blue pencil discharge are very efficient in relieving swollen and inflamed joints and muscular spasm anywhere.

Blue Pencil Discharge.—The connections should be

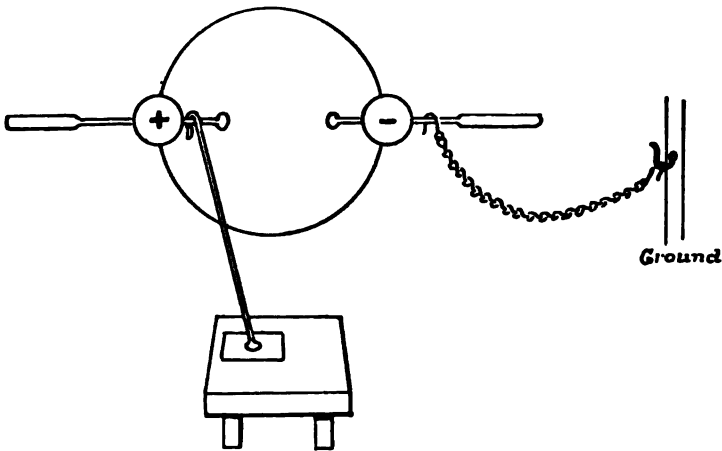


Fig. 59.—Positive insulation.

made as shown in Fig. 58. The first effect of a blue pencil discharge on the skin is one of ischemia followed by hyperemia. This application is useful in ecchymoses, sprains, contusions (black eye), swollen joints, muscular spasm, neuralgia and in some cases of neuritis.

It is useful as an adjuvant in skin diseases accompanied with pruritus, and when applied to the dorsal vertebræ increases intestinal peristalsis. After a prolonged application to the spinal nerves it causes drowsiness and perspiration. The dose is regulated by the distance of the electrode from the patient. If the electrode is held

too close to the patient unpleasant sparks will result, if too far away the patient receives no current. The length of the discharge depends upon the capacity of the machine. The capacity of the machine may be controlled by regulating its speed by means of a speed controller. The dose should always be within toleration of the patient.

Static Insulation (Electro-static bath).—The connections are made as in Fig. 59. This is the mildest form of

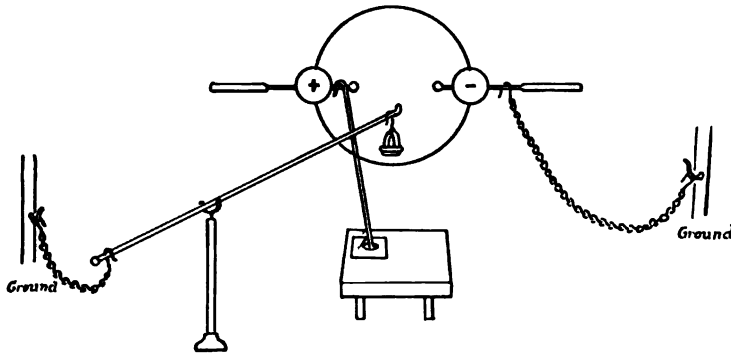


Fig. 60.—Head breeze, indirect.

static treatment. It is employed when we desire a general sedative effect as in mild neuroses. Dr. N. S. Neiswanger recommends this form of application in Bright's disease. It increases metabolism and elimination of the products of combustion through the kidneys. It is much milder in its effects than potential alternation. The platform should be connected to the positive pole of the machine since the negative pole is apt to be irritating to susceptible individuals.

The strength of the charge may be increased by placing the foot plate under the legs of the chair on which the patient is seated. It may be further increased by having the patient's feet directly on the plate.

Indirect Spray or Head Breeze.—Connections should be made as shown in Fig. 60. The crown is either attached to the top of the machine or to a standard made for the purpose and properly grounded. This connection produces a mild form of static breeze which is useful in insomnia. The positive head breeze has a soothing effect upon tired nerves while the negative is more or less irritating.

Indirect Positive Spark (Fig. 61.)—Illustrates the

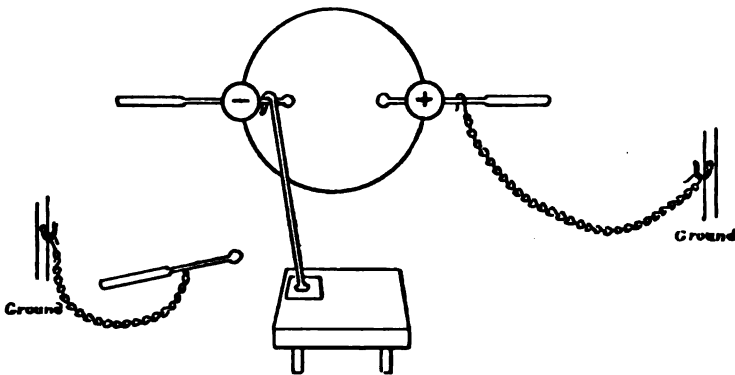


Fig. 61.—Positive spark, indirect.

proper arrangement for administering an indirect positive spark or spray. If a ball electrode be employed the patient will receive a spark, the force of which depends upon the size of the ball electrode allowing the output of the machine to be the same. If a multiple-point electrode be used and held at the proper distance from the patient a cooling sedative spray will result. The mildest spray is from a wet wooden electrode and is the form that should be used in mild muscular pains.

Direct Spark (Fig. 62).—Shows the proper connections for the administration of the direct spark. This treatment is given for muscular spasm, severe myalgias and some-

times locomotor ataxia. It is more or less severe depending upon the size of the electrode, its material (whether of wood or metal) and the method of application.

Static Wave.—This is a pulsating vibratory current. Fig. 63 shows the proper connections. A metallic plate on the platform is connected with the positive pole of the

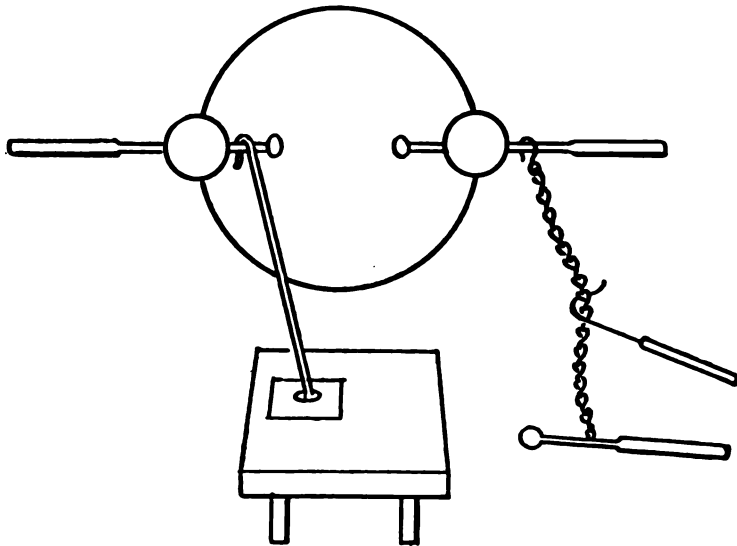


Fig. 62.—Direct spark.

machine by means of a metallic rod, the negative being grounded. The patient is placed on the platform with his feet upon the plate. The effects are the same if he holds the connecting rod in his hands. While the feet are upon the plate there may be a discharge through the shoes causing considerable discomfort in which case the shoes must be removed or the rod held in the hands. The strength of the current is regulated by the distance between the discharging rods. At first the discharging

rods should be in contact. The current is strengthened by slowly separating the rods. The current is usually painless, but it should be always regulated so as not to produce unpleasant effects. Its therapeutic value lies in its pulsatory and vibrating effects. It stimulates glandular tissue and by its rapid delivery of charges lessens sensibility. It relieves muscular spasm, drains engorged

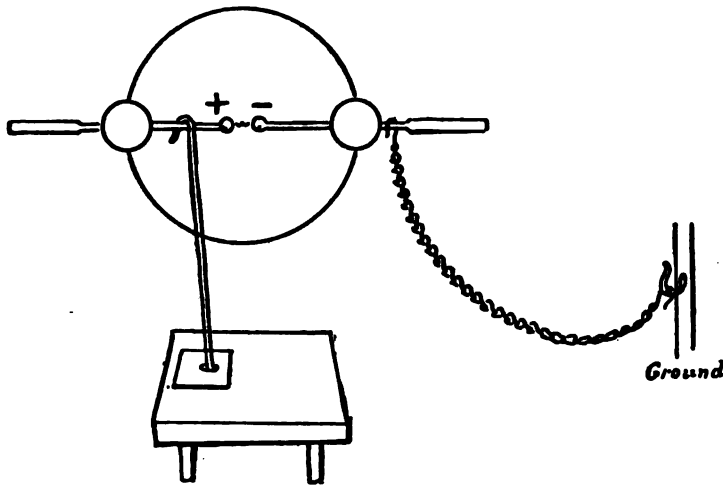


Fig. 63.—Static wave.

tissue and increases metabolism. The current may be applied through a wet sponge or bare metal electrode to any parts of the body desired.

Fig. 64 shows the connections for a modified or condensed form of the static wave current. The Leyden jars of the machine are placed in the circuit or one jar is placed in the grounded circuit.

This modified form is the one employed in my treatment of prostatitis. The object of this modification is to increase the force of the pulsatory charges.

Static Wave Through a Vacuum Electrode.—Fig. 65 illustrates the proper connections for the use of a vacuum electrode. Its principal use is in differentiating neuritis from neuralgia. The technic of this application will be considered later. I have seen this form of static current described as being a high-frequency current. It is

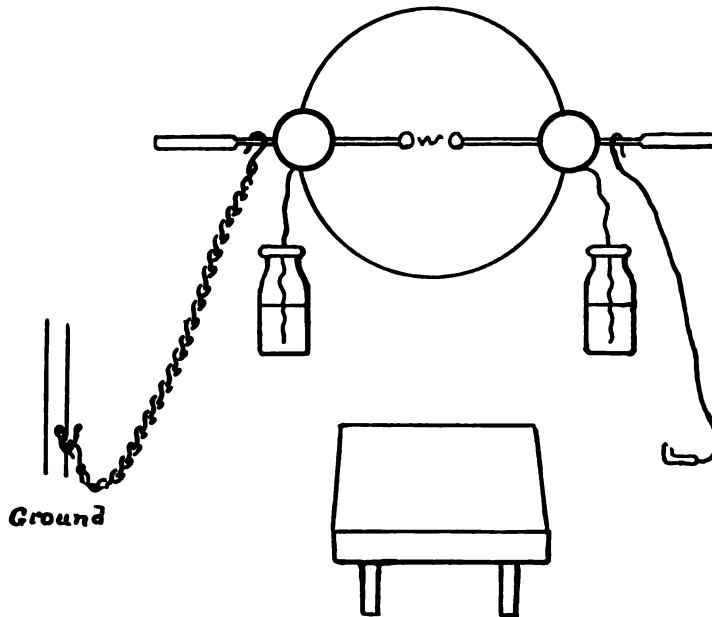


Fig. 64.—Static wave connection for treatment of prostatitis.

in no sense a high-frequency current and its effects differ in degree only from those of a metal electrode of the same size, being somewhat milder. Grounding the opposite pole increases its effects.

Static Induced.—Fig. 66 shows the usual connection for a static induced current. There are several modifications of this connection. The binding posts as shown are connected with the outer coating of the Leyden jars. The

strength of the current depends upon the size and number of jars in the circuit and the distance between the discharging rods. The weakest static induced current is produced by connecting the patient to the outer coating of a small Leyden jar, the inner coating of which is connected with one pole of the machine, the other pole being free as illustrated in Fig. 67.

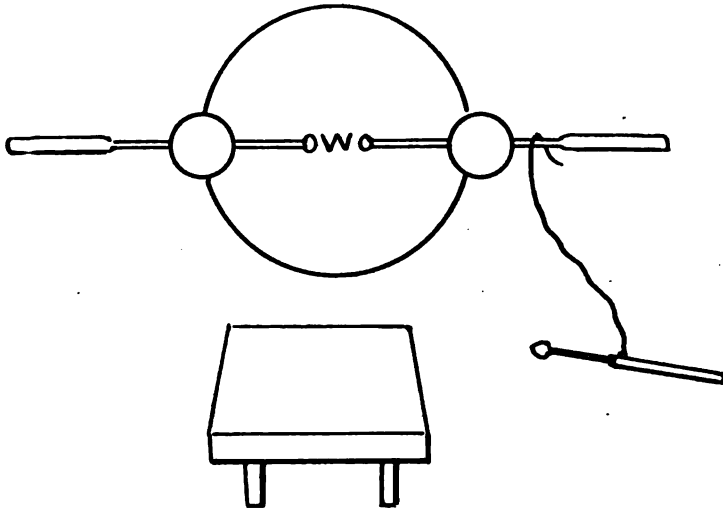


Fig. 65.—Static wave through vacuum tube.

The current may be increased by grounding the opposite pole as in Fig. 68.

It may be further intensified by using two Leyden jars, the outer coats being connected to the patient by means of two electrodes as illustrated in Fig. 66. The electrodes may be of metal or wet sponge. The contact of the electrodes, whatever the material may be, must fit the part perfectly to avoid unnecessary sparking which is disagreeable to the patient.

The static induced current has the widest range of usefulness of all the static currents. It may be employed in almost any condition where the faradic current is indicated.

Static sparks are not popular with patients. While they are not always painful, the effect upon the patient's mind is such as to almost overcome their usefulness.

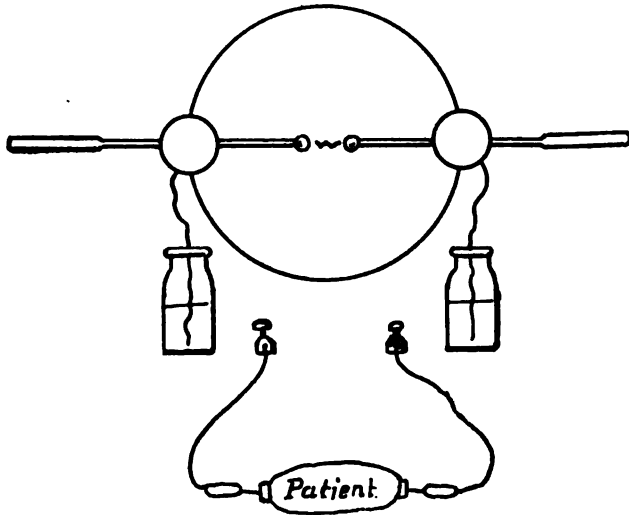


Fig. 66.—Static induced current.

In nearly all cases the static spray, *blue pencil discharge* or static wave may be substituted for the disagreeable spark with as good results. When it is thought best to use the direct or indirect spark, it may be administered through a water filled wooden electrode with the minimum amount of pain.

The pains of *chronic* sciatica may be relieved by the following technic. Place a large wet sponge or block tin electrode over the abdomen and connect to outer coating of the Leyden jar on the negative side of the

machine; connect the other jar with a small ball electrode and apply to the painful points; regulate the current strength by the distance between the discharging rods of the machine which should be separated far enough to produce mild muscular contractions. The pains should be relieved in ten minutes, after which static insulation should be used for ten minutes for its general effect upon metabolism. This technic may be employed in neu-

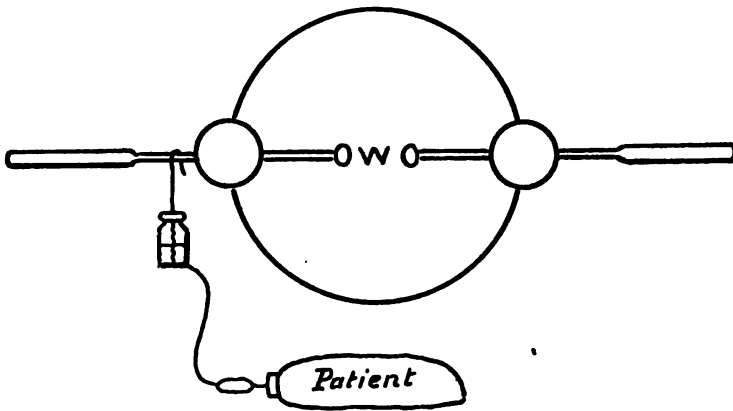


Fig. 67.—Mildest form of static induced current.

ralgias anywhere in the body. Do not employ this method in acute neuritis. While it will occasionally relieve acute neuritides it has been my experience that it nearly always aggravates the condition.

Furuncles may be aborted in the early stage by application of the positive pole of the induced static current to the offending part with the negative pole grounded. If applied early it will prevent suppuration, if a little late, it will hasten evacuation.

The static induced current is useful in muscular atrophy in keeping up nutrition until the nerve connection is restored. This current may be used with sufficient

intensity to break up adhesions about stiff joints. It is also useful in removing fluid from the tissues and joints. It may also be used with benefit in joints infected by gonorrheal toxins. If the germs are present in the joint it is of doubtful value and may aggravate the condition.

I know of no therapeutic measure so beneficial as the static wave current in draining engorged glandular or connective tissue.

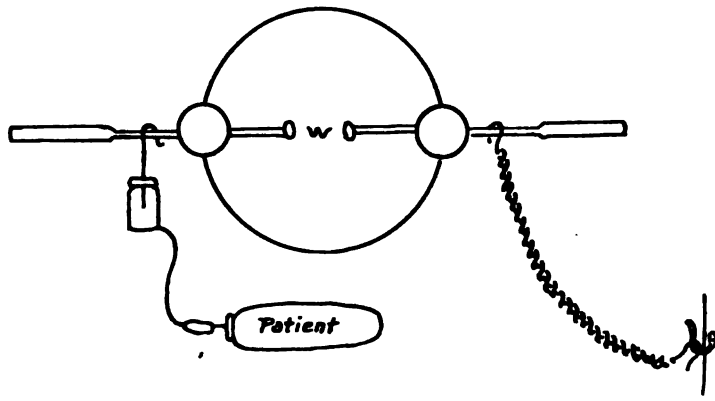


Fig. 68.—Mild static induced current, increased by ground.

It is not necessary to insulate the patient during treatment by the static induced current.

When applied early in arthritis deformans it will prevent muscular atrophy about the joints.

There seems to be quite a difference between the effects of a *brush discharge* from a moistened wooden electrode and a *blue pencil discharge* from a metal-point electrode. If the machine be run slow the wooden electrode will emit a sputtering discharge. When applied to ulcerating surfaces it seems to bring about healthy granulations, probably due to its stimulating effects. This form is usually employed in sprains. It reduces swelling and

relieves pain. The electrode must be kept moving during the application. The effects are similar to the effleuve from a high-frequency machine.

The best effects from a *blue pencil discharge* are obtained from rapid revolving plates of a machine sufficient



Fig. 69.—Baker Model T 4-8.

in capacity to produce a flame 12 or more inches long. This application should be made to the bare skin.

Fig. 69 is an illustration of the Baker Model T static machine. It is of the Toepler-Holtz type. The revolving plates are composed of fibrous material which are very little affected by machine products. Revolving plates made of glass cannot be run safely over 350 revolutions per minute while the fibrous plates of this machine may be run safely as high as 1800 revolutions per minute, thus

insuring a great capacity for all kinds of work. The manufacturers give the following specifications for this machine.

Size: Width, 40 inches; depth, 29½ inches; height, 47 inches; weight, 150 pounds. Knock-down case, ball bearings, fibrous revolving plates, glass stationary plates, patented field regulators, standardized jars and coils, discharge rods graduated, speed 400 to 1800 revolutions per minute. Output: 0.8 to 1 milliamperes, 300,000 volts. Power required to run it: ¼ horsepower motor which may be connected to any house lighting circuit.

TYPES OF STATIC MACHINES.

Modern static machines comprise three types, the Holtz, Toepler-Holtz and Wimshurst. While the Holtz machine delivers a longer and steadier spark than the others my choice for all kinds of work is the Toepler-Holtz type. Its advantages are in the large current strength sufficient to excite an x-ray tube; a better source for high-frequency currents and its self-exciting feature. The revolving plates when made of fiber may be run at a high rate of speed without danger of breaking and they do not furnish a suitable surface for collection of moisture and nitrous acid fumes, etc.

The Wimshurst type is complicated in construction and always liable to get out of order.

CARE OF A STATIC MACHINE.

The efficiency of a static machine depends largely upon atmospheric conditions. Very little moisture inside the case will prevent it from taking its charge. It is therefore important to keep it as dry as possible. Moisture outside the machine will also impair its efficiency. In very moist climates it is advisable to apply a very

little coal oil to the glass part of the case. Moisture will collect less on fibrous than glass plates.

Whenever the ordinary spark decreases in volume and shortens in length it is an indication that moisture is collecting inside the case. Under such conditions do not wait for the machine to stop generating, but place within the case 10 to 20 pounds of unslaked lime. Place the lime in an open top box, in the sides of which have been bored several $\frac{1}{2}$ inch holes. Line the box with muslin and place the lime therein and cover with two layers of muslin. Opening the case for this purpose will allow more moisture to enter. It will require 24 to 36 hours for the lime to absorb the moisture. In case the machine refuses to take its charge at any time on account of moisture and it is desired to use it for an emergency case, the moisture may be removed temporarily by placing therein several glass jars containing ice and salt. The moisture within the case will condense on the jars and the machine will generate long enough for one treatment. Keep the machine clean inside and out. Keep the room free from dust and moisture. Give it as good care as you do your watch and it will not disappoint you.

POLARITY.

There are several ways of testing the polarity of a static machine. The most convenient one is to place the discharging rods about two inches apart and while the current is passing apply a match held in the hand to either pole; on the positive side the spark will follow the match, on the negative it will not.

CHAPTER V.

HIGH-FREQUENCY AND SINUSOIDAL CURRENTS.

Definition. Condensers. Types of machines. Spark-gaps. Physiology of high-frequency currents. Desiccation, its effects and indications. Electrocoagulation. Tunneling the prostate. Electrodes. Care of electrodes. Preparation of patient. General technic. To relieve pain. Auto-condensation. Autoconduction. Contraindications. Sinusoidal. Lateral curvature. Intestinal stasis. Indicanuria.

DEFINITION.

A HIGH-FREQUENCY current is one characterized by the high number of cycles completed in one second of time. It is a modified alternating and oscillating current. The ordinary alternating current which completely reverses itself 120 times per second is known as a 60-cycle current. It requires one positive and one negative alternation to complete one cycle. The 60-cycle alternating current is the one usually chosen for street lighting because it is much cheaper of production than the direct current.

An oscillating current, while alternating in character, differs from the ordinary alternating current in the wave length of the alternations. The modification is brought about by the introduction of condensers into the current.

The alternating current is one in which the current is constantly changing from positive to negative, the waves being of equal length. This current, while it will light up vacuum tubes, is not a true high-frequency current, even though its frequency be stepped up to a high number of alternations. It lacks the oscillating character.

An oscillating current is characterized by long and short alternations, due to the change in the force of the current as discharged from condensers.

The ordinary 60- or 133-cycle current is of low frequency. The sinusoidal is usually one of medium frequency, and either of these currents produces muscular contraction. When the frequency is increased beyond the ability of the muscle to contract or respond it becomes a current of high-frequency.

When an oscillating current completes 10,000 or more cycles per second it becomes a true high-frequency current. The oscillations from an ordinary high-frequency apparatus are so far beyond those of light or sound that they cannot be perceived by the human senses.

A direct current may be broken up into a series of waves by an induction coil, and when so broken up it is known as a pulsatory current.

A high-frequency current is increased by a stepup transformer—its oscillating character produced by condensers—and becomes a true high-frequency current regardless of whether the original current were uni-directional or alternating.

A high-frequency current possesses qualities unknown to other currents. It does not require a conducting wire to make a circuit, which may be demonstrated in unipolar applications.

CONDENSERS.

The Leyden jar or some other form of condenser is an essential part of every high-frequency apparatus. It received its name from the town of Leyden, France, where its discoverer lived. It was discovered several centuries ago and consisted at that time of a glass jar partially filled with water. Now it consists of a glass

jar coated on the outside and inside with tinfoil to about one-half its height, and with a brass rod fastened to the cork and connected with the inner coating by means of a loose chain, the brass rod terminating above in a knob. To charge it, the knob on the upper end of the rod is brought near enough to one pole of electricity to receive a charge by conduction, while at the same time the outer coating of the jar is grounded. A rod of carbon may be substituted for the brass rod and chain. The inner coating becomes fully charged with electricity, and the outer coating, separated from it by only $\frac{1}{8}$ -inch thickness of glass, becomes charged by induction. The charge of the outer coating is attracted into it from the ground. The two charges being greater than either alone, in consequence of the attraction of the two for each other, condensation of electricity is produced.

A charged Leyden jar will retain its charge for a long time. It may be handled and even the foil be removed and replaced again, without losing its charge.

Simultaneously touching the outer coating and the knob connecting the inner coating will produce a discharge, such charge producing physiological effects in proportion to the size or number of jars.

Another type of condenser used where a large surface is required or where the tension of the current is comparatively low, consists of some dielectric such as glass, mica or paper, between which are sheets of a conductor, like tinfoil.

Condensers constituted of a paper dielectric deliver a rough current and are liable to burn out during heavy work of diathermy, consequently a high-frequency apparatus with Leyden jars as condensers is preferable.

The charge received from the street current and a discharge across the spark-gap, taking place at the same

time as the charge and discharge in the coil, create an oscillating current. The oscillations are not 50 or 60 per minute, but many millions per second, which constitute a high grade of high-frequency current.

High-frequency currents, however, are alternating, and the alternations are so rapid that the sensory nerves are unable to respond. This fact makes them safe to use. The lower the frequency, the more dangerous the current.

The electromotive force in a secondary coil depends upon the number of turns in the primary coil and upon the frequency of interruptions of the current in the primary. Every interruption is coincident with a change in the direction of the current.

TYPES OF MACHINES.

All high-frequency machines are constructed upon the principle of d'Arsonval or Tesla. There is, to my knowledge, no manufacturer in the United States, making a true d'Arsonval machine. Practically all of the machines on the market today are combinations of the Tesla, modified d'Arsonval and Oudin types.

The d'Arsonval is one of high-frequency and high-amperage, but of low voltage. It consists essentially of an induction coil receiving its charge from a direct current. The terminals of the secondary coil are attached to the inner coating of two Leyden jars. In the circuit between the inner coating of these jars is placed a spark-gap. Between the outer coatings of the jars is a coil of coarse copper wire called a solenoid. The current derived from this type of apparatus is known as the d'Arsonval current (Fig. 70).

The inner coating of the first jar is highly charged with positive electricity; the inner coating of the other

jar is negative and attracts the electrons from the first jar, the charge being of sufficient voltage to jump the spark-gap placed between the jars. This immediately charges the outer coating of the second jar with positive electricity by induction; this in turn is attracted to the outer coating of jar number one, and, in passing to the jar it traverses the solenoid to which the patient is con-

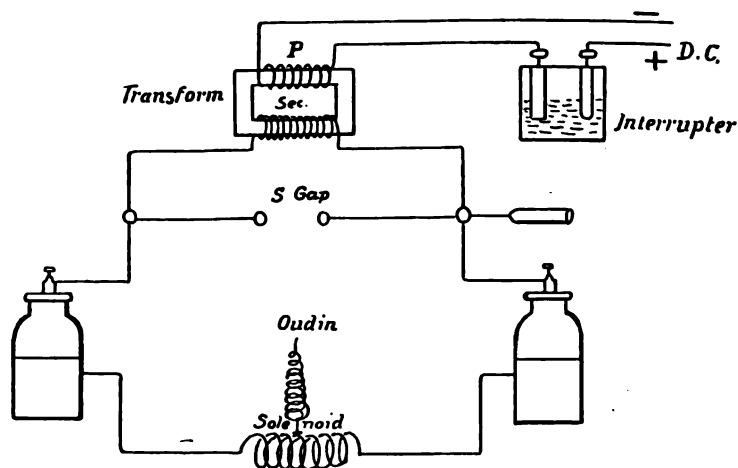


Fig. 70.—D'Arsonval high-frequency current.

nected. As the current oscillates to and fro through the condensers or jars as well as through the coil, a high-frequency current is produced (Fig. 70).

Oudin found that by adding another coil properly tuned to the d'Arsonval solenoid he could change the d'Arsonval current of low voltage and high amperage to one of high voltage and low amperage, resembling the current of the Tesla apparatus. This additional coil is known as the Oudin Resonator. (See Fig. 70.)

High-frequency currents cannot be measured by the ordinary electric meter. In order to approximate the

amount of current passing from a high-frequency apparatus a thermostat is used and is known as a hot wire meter. As a matter of fact it measures the amount of heat instead of the electromotive force coming from the apparatus, while an electric meter measures the electromotive force or amperage of the current.

SPARK-GAPS.

In order to facilitate the charge and discharge of the Leyden jars of a high-frequency apparatus a gap or dielectric of air is introduced between the jars, this gap being



Fig. 71.—Multiple section spark-gap with tungsten spark points enclosed. It is noiseless in operation. It is arranged to be connected to an air pump or tank allowing free passage of air through the entire gap thus preventing it from overheating.

known as a spark-gap. Any resistance introduced into the circuit of any electric current has the effect of increasing its power. A spark-gap not only acts as resistance but multiplies the oscillations of the current. The original high-frequency machines were supplied with but a single-point spark-gap. A multiple-point spark-gap increases the efficiency of the current. There are many different forms of spark-gaps used on high-frequency machines. I have used in high-frequency work single-point, multiple ball, rotary and multiple section spark-gaps. Resistance creates heat, and if the spark-gap is not kept cool

the formation of ozone and nitrous acid soon corrodes the points and becomes a source of considerable annoyance.

PHYSIOLOGY OF HIGH-FREQUENCY CURRENTS.

The physiological action of high-frequency currents varies with the type of apparatus as well as the method of application. Increased metabolism is one effect common to all methods of application. Applications which induce currents in the human body have a general seda-

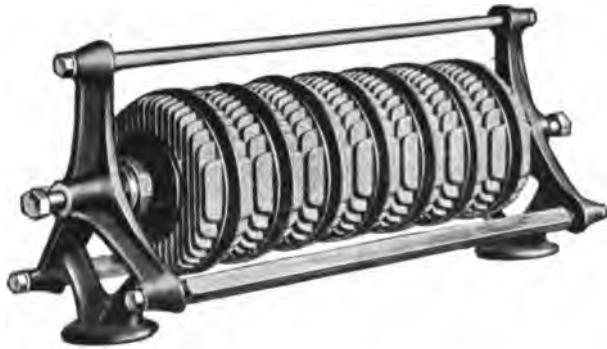


Fig. 72.—Multiple spark-gap is a new departure from the prevailing types of high-frequency spark-gaps. It is self cooling and almost noiseless in operation. The gap weighs about 35 pounds and is designed for hard service.

tive effect upon the vasomotor mechanism and reduce blood-pressure. Sparks from a vacuum tube have a local stimulating effect, and when applied to the spine have a tendency to raise the blood-pressure, especially in cases of hypotension.

If a metallic or vacuum electrode be placed in good contact with the skin or mucous membrane a current up to 250 milliamperes will produce no sensation other than that of heat, but a current from a vacuum tube of over 250 milliamperes will produce a slight sparking sensation in addition

to that of heat. A current from a multiple-point metal electrode held away from sparking distance produces an aura having a sensation of a warm breeze and is sedative and soothing to tired nerves. A shower of long sparks from either a metal or vacuum electrode will prove very irritating, and if long continued will produce burns varying in severity from a blister to necrosis. Considerable constitutional effects may be produced by local application without much visible local effects.

The first effect upon the skin is one of vasoconstriction. This is followed by dilatation of the capillaries and consequent hyperemia; there is also a certain degree of anesthesia produced. Whenever there is a break in an electric current ozone is produced. There is considerable ozone driven into the skin during a séance of vacuum application. Repeated applications will tan the skin, and if too much current be employed a pimply eruption may result.

The current promotes activity of tissue changes, which fact is proven by the disappearance of chronic infiltrations. The activity of sweat glands of the skin is visibly increased. The secretion unites with the nitrous acid and ozone produced by the current and sticks to the electrode, and if the electrode is not kept in motion disagreeable sparks will occur. A liberal supply of talcum powder will enable the electrode to slide easily over the surface, but after a very few minutes of application you will find adhering to the electrode a hardened mass that will require a strong soap or washing powder and water to remove. The body will retain a peculiar odor, perhaps lasting for hours after a general application by the vacuum electrode. The action of ozone and nitrous acid is taken advantage of in the treatment of indolent ulcers. It is not only stimulating but has a bactericidal effect upon the ulcer.

It also produces phagocytosis which is an element in cleaning up the ulcer.

A prolonged application of heavy sparks will destroy hair follicles and consequently cause falling out of hair. It will plug small arterioles with products of gas and cut off the circulation. This explains how a neoplasm may be destroyed by lack of nutrition, without necrosis. When destroyed in this manner there is no resulting scar. Applications to mucous membranes produce hyperemia and stimulation of secretion.

Deep effects of local application of high-frequency currents produce very little sensation and no muscular contraction. If muscular contraction be desired you will have to use some other modality such as faradism, static wave, sinusoidal current or interrupted galvanic current. You may be able to get a vibratory current by connecting a vacuum electrode to one pole of an x-ray coil.

The greatest effects upon body metabolism are secured through muscular contraction which may be produced with a d'Arsonval current, by applying both poles to the patient through metal electrodes and introducing an air-gap in the circuit; but this is an unsatisfactory method. In order to practice electrotherapy successfully you should have all modalities.

High-frequency currents penetrate more deeply than other electric currents and have a more profound effect upon the lymphatic and other glands. There is no current outside of the static that will effect the bronchial glands. Its local stimulating effect upon blood-vessels makes it successful in therapy of phlebitis and varicose veins. Upon chronic indurations it has a resolvent effect: it drains infiltrated tissue anywhere. Applied over the abdomen it stimulates gastric and intestinal peristalsis.

In local applications by means of the vacuum tube the effects may be increased by having the patient connected to the opposite pole of the machine.

Dispossess yourselves of any idea that you are administering ultra violet rays through a vacuum electrode. While a few may be present within the tube, they never reach the patient in quantity to be effective.

High-frequency currents produce wonderful mechanical effects. The shooting of electrons through every cell of the body must *per se* have a great effect upon the electrons that compose the cell. In addition to the mechanical effect we also have profound thermic effects. The general and deep thermal effects of high-frequency currents will be taken up under the head of diathermy.

Strictly local application of a high-frequency current produces an increased activity of the cell and increases the resisting power toward pathological processes. In administering these treatments we must avoid overheating the cell which might lead to permanent changes in its protoplasm.

DESICCATION.

Surgical uses of high-frequency currents are employed when we desire to destroy the tissues by heat. While many different electrical methods of destruction have been employed for many years, it was the good fortune of Dr. William L. Clark, of Philadelphia, to bring forward a method devised by himself for the destruction of adventitious tissue. This method he named "Desiccation." I have been using this method for several years, and with the experience gained I am able to corroborate his published statements of the results obtained: therefore, I hope I may be pardoned for quoting freely from his article on the subject.

Dr. Clark uses a high potential static current passed through a resonator and Leyden jars. He contends that he secures better results than from an ordinary high grade high-frequency apparatus. I have been able to duplicate his results with a Tesla type of machine, and I believe that anyone who understands how to operate an efficient high-frequency apparatus can do as well.

The field of application of Clark's method is limited to accessible growths on the skin and mucous surfaces. The advantages of his method are: (1) The rapid and effective destruction of abnormal growths without the loss of blood; (2) precision: considerable area may be destroyed without infringement upon normal tissues; (3)



Fig. 73.—Fulguration vacuum electrode. This consists of a vacuum tube surmounted by a platinum terminal, the sparking distance to patient being regulated by a glass shield which slides over a cork bushing. This electrode can be used with handle as used with the other vacuum electrodes.

no instrument of any kind enters the growth; (4) normal cells are left intact; (5) sterilized wounds result; (6) the blood and lymph channels are sealed, which lessens the likelihood of metastasis in cases of malignancy; (7) the cosmetic result is good, leaving no contracted cicatricial tissue.

Heat effects as applied to living tissue range in degree from simple hyperemia to carbonization. There is a point between the two which is called the desiccation point. Desiccation is a dehydrating process, rupturing the cell capsule and transforming it into a dry mass. For the purpose of application of this method a needle-pointed instrument, known as a fulguration electrode, is

used. The electrode is never brought into contact with the tissue, but an air space of from $\frac{1}{8}$ to $\frac{3}{4}$ of an inch is interposed between them. The electrons are thrown from the metal point into the tissues, the sparks following one another with such rapidity that to the eye the appearance is that of a luminous glow.



Fig. 74.—Application of desiccation.

Another method of producing desiccation may be employed: It is the indirect, called by some the “disruptive arc” method, the technic of which is as follows: Place the patient upon the auto-condensation couch or pad and connect it as in the unipolar method. Connect the fulguration electrode to a water pipe or other good ground; place point of electrode upon the spot to be treated, switch on current of sufficient strength to do the work desired. For mucous surfaces this method has some advantages.

There are other methods of electric destruction of tissue: Electrolysis, which destroys tissue by chemical or electrolytic action of the galvanic current; ionic surgery or cataphoresis as practiced by Massey, of Philadelphia, and destructive fulguration or high-frequency cauterization.

The term fulguration is commonly used when desiccation, coagulation, carbonization, high-frequency cauterization or genuine fulguration by the deKeating-Hart method is used. Fulguration as practiced by deKeating-Hart does not destroy tissue. The method consists of applying long sparks of 6 to 10 inches to the field in malignant disease after radical operation, changing the nutrition of the part to such an extent as to prevent the formation of cancer cells.

Effects of Desiccation: The area and depth that may be desiccated with one application are controlled by the operator and depend not only upon the current strength whether unipolar or bipolar, but on the distance of the electrode from the body, time of application and density of the tissue.

Desiccation is usually, but not always contraindicated in neoplasms that are covered by healthy skin, as in order to reach the diseased tissue the skin must be destroyed. After the application a dry crust forms at once and the time required for separation depends upon the character of the tissue. In case of mucous membranes the desiccated tissue soon becomes macerated by the secretions and may separate within a few hours, while on the skin surface it takes a longer time. Regeneration of skin or scar tissue often takes place underneath the crust. It is my practice to leave the crust in place until the healing has taken place underneath.

A few long sparks applied at first will usually anesthetize sufficiently the point to be destroyed, except in supersensitive persons. A local anesthetic may be used where the growth is non-malignant. In rare cases a general anesthetic is required. Gas-oxygen is the form preferred. Chloroform may be used except when the field of operation is within the mouth or throat. Ether must never be employed on account of its inflammability.

Desiccation is applicable to the treatment of warts, moles, nevus, chloasma, tattoo marks, keloid, papilloma of the bladder, urethral caruncle, urethral granulations and infected urethral glands, some forms of hemorrhoids and rectal ulcerations, tumors in the nose, throat, mouth and larynx. In cases of malignant growths, when a large area is involved, Dr. Clark recommends a short course of Röntgen-ray treatments following desiccation, lest there be some cancer cells that have possibly escaped desiccation.

In conclusion: desiccation is a successful treatment for all accessible benign neoplasms or lesions of the skin and mucous membranes. It is curative in the great majority of localized malignant lesions of the skin and mucous membranes.

ELECTROCOAGULATION.

Doyen employed the high-frequency current for the destruction of cancer cells by heat. The cell destruction in this method is the result of tissue coagulation. If the electrode be held at a distance from the part being treated the sparks will cause a superficial coagulation, but when applied directly to the part, with the opposite pole of the machine at some indifferent part of the body (bipolar) the tissues are coagulated to almost any desired depth. To this method Doyen applied the term *bipolar voltaization*.

This method is diathermy carried to the point of destruction of tissue. Desiccation is a dehydrating, and electrocoagulation a destructive, process.

Electrocoagulation has been employed for the treatment of benign as well as of malignant tumors of the bladder by Doyen and Luys in France, Berndt in Austria and Nagleschmidt in Germany, as well as a number of men in this country.



Fig. 75.—Fischer foot switch. For fulguration, or in any work where the current is turned off or on to advantage without the use of the hands, this foot switch will be found exceedingly convenient. Arranged that the current can be left on or off indefinitely by merely pushing forward or backward the contact lever.

TUNNELING THE PROSTATE.

Dr. Georges Luys, of Paris, employs a combination of galvanocautery and electrocoagulation in tunneling the prostate for the purpose of restoring the urethra to normal in cases of prostatic hypertrophy. He employs a direct vision cystoscope. He brings the vesical end of the cystoscope in line with the neck of the bladder. Then with galvanocautery cuts vertically the prostatic bar. Then the burned section is enlarged by tracing the letter V, the two arms of which will diverge to the extent to which the searing process has been carried out. The lower point of the V rests on the lowermost part of the bladder. The second step in the work consists in the destruction

of the lateral lobes by digging into them as one would dig potatoes. He actually digs a tunnel extending from the neck of the bladder to the posterior border of the verumontanum. This work is done at several sittings (four to six) at intervals of eight days. He stops the bleeding with electrocoagulation which acts like a hemostat upon a cut blood-vessel. This tunneling of the prostate is without danger. No anesthesia is required. Dr. Luys claims absolute cure of the condition by his method.

This operation may be done entire by the electrocoagulation method by plunging the electrode into the substance of the prostate to which it soon adheres. When the electrode is withdrawn it brings a portion of the prostate with it and by a digging process the offending portion may be removed.

ELECTRODES.

Almost every conceivable material that absorbs moisture has been tried in the manufacture of electrodes, for application of the different electrical modalities, but as our interest is centered in high-frequency currents, only those of practical importance in this connection will receive our attention at this time.

In my practice with high-frequency currents I have used electrodes made of tinfoil, zinc, lead, copper, brass and pure block tin. I have also used wet felt, wet absorbent cotton and wet turkish toweling. However, I know of no application of high-frequency currents where wet electrodes are indicated. My favorite electrode for static and high-frequency currents is fashioned from pure block tin, to suit each individual case.

Heavy metal electrodes are furnished with nearly all high-frequency machines, but pure tin has the following advantages:

(1) A suitable electrode for the individual case in hand can be fashioned in one minute. (2) They are pliable and can be made to conform to almost any contour of surface. (3) They are much cheaper. (4) A more even distribution of the current is possible and concentration of current upon one point or edge of the electrode avoided, provided the fine wire of the reophore is properly distributed over the electrode. Suppose two ordinary metal electrodes of any size or shape be placed near each other upon any part of the body, the current will concentrate upon the edges which approximate each other. (5) While the pure tin electrode will corrode in time, it is less liable to corrosion than any which I have tried.

In fashioning a pure tin electrode care must be exercised. The edges must be made smooth in order to prevent sparking; they should be in circular or oval form. Disagreeable sparks are liable to occur from the sharp corners of a square or rectangular electrode, and, again, the sharp corners are liable to press too deeply into the skin and cause a concentration of current at that point. Concentration of current is apt to occur at the point of attachments, such as snap button, soldered or snapped-on reophore sockets. Especially is this true in application of heavy diathermic currents. Care must also be exercised to see that there are no points of the electrode which are not in close contact with the skin, as perspiration may collect and vaporization cause a burn. When a small area is to be treated by diathermy the heavy electrode (metal), with a handle, has its advantages.

Vacuum electrodes for the purpose of delivering charges of high-frequency are made in almost every conceivable form to conform to the anatomy of the part to be treated.

The vacuum of these electrodes or tubes varies from a very low to a very high degree. The degree of vacuum may be estimated by the color which is emitted. One of low vacuum emits a reddish glow and is the one of choice where relief from pain is the object to be attained. One of medium vacuum emits a bluish tint and one of high vacuum has a whitish appearance. A greenish tint indicates the presence of x-rays. In chronic conditions of the skin, ulcers or cases of prostatitis, the electrode of bluish or white fluorescence is the one of choice.

Some tubes have a leading-in wire, others have a single chamber, while still others have a vacuum divided into two chambers, connected by a small tube, surrounded by a chamber which is open to the air. The last mentioned tubes are known as insulated glass electrodes and are the ones of choice in applications to be made in the urethra, vagina and rectum.

When an electrode is used in the urethra, vagina or rectum, some kind of lubricant is necessary to prevent sticking to the mucous membrane. Almost any kind of cerate, vaseline or tragacanth jelly may be used. My preference is tragacanth jelly as it is soluble in water. If kept in collapsible tubes it is aseptic. A prolonged application of high-frequency current to any mucous surface is liable to cause a burn.

It is my practice to limit such application not to exceed eight minutes. When I apply it to a patient for the first time, I limit the time to six minutes.

Inflammable material is liable to be set on fire by high-frequency currents. In treating the scalp be sure that all kinds of ornaments are removed. Many ornaments are composed of celluloid, an exceedingly highly inflammable material. Also avoid short fuzzy hair. If you ever use an urethral electrode of glass, be very care-

ful in its employment, lest you have an external urethrotomy on your hands for the removal of pieces of broken glass. I never use them.

There is a so-called cataphoric glass electrode made and recommended by some for the ionization of drugs, but it is practically useless since a high-frequency current is an alternating one and has but little, if any, ionizing power. In order to drive medicaments into the skin a direct current is necessary.

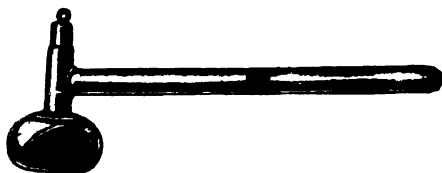


Fig. 76.—The above is an illustration of a non-vacuum electrode. In many respects these metal lined electrodes are superior to the vacuum electrodes. There is a direct metal conduction with the lining of the electrode and as there is no vacuum to overcome, the efficiency of the current when it reaches the patient is materially increased. The glass is heated quickly and a greater degree of heat reaches the patient than is possible with a vacuum electrode. They may be employed with any electric current. When employed with the static current a direct positive charge may be delivered which is impossible with a vacuum electrode. They are not easily broken and may be sterilized by boiling. They are a distinct improvement over the vacuum electrodes in high-frequency work.

Care of Vacuum Electrodes.—Vacuum electrodes may be sterilized by boiling. In case a sterilizer is not at hand they may be washed with soap and water and immersed in a 3 to 5 per cent. solution of lysol or a 30 per cent. solution of carbolic acid. Some recommend keeping them in a formaldehyde sterilizer. This kind of sterilizer begins and ends in show.

The form of electrode to be used is practically one of personal selection.

Sometimes the measurement of dose is one of difficulty to the beginner. In the first place you must have an efficient apparatus. The high-frequency machines that may be carried in the coat pocket or a hand grip, with a cord supplied to attach to any lamp socket, are practically worthless. Whenever I see any one having such an one in his possession it engenders within me a feeling of sincere pity.

While every efficient high-frequency apparatus has an attachment in the form of a hot wire meter to measure the amount of current passing in diathermy and auto-condensation applications, by the usual unipolar method of application by vacuum electrodes the current is not measured, but its strength may be estimated by the length of the spark emitted from the tube.

In ordinary applications the vacuum electrode should be kept in contact with the skin and always moving.

The effect of a tube delivering any length of spark will be as effective as if held at the limit of sparking distance, and much more comfortable to the patient. If you desire to awaken him from his lethargy and get an expression of what he thinks of you and your machine, give him a 2-inch spark from a condenser electrode.

Preparation of the Patient.—The preparation of the patient all depends upon the method of application and effects desired. If no sparks are desired all clothing from the part to be treated must be removed. Metal of all kinds, such as ornamental chains, corset steel, hairpins, etc., must be kept out of sparking distance of the electrode. If a mild spark be desired, the application may be made through a sheet or thin underwear. A spark through the clothing will have the same effect as if the

electrode were held the same distance from the skin, as represented by the thickness of the clothing.

General Technic.—In treating diseases of the skin, such as acne, eczema, etc., a reasonable charge is required. The electrode should be kept in contact with the skin and moving. If itching occurs raise the tube, allowing a few short sparks to escape. In skin ulcers a layer of gauze is useful for two reasons: (1) It keeps the electrode clean. (2) It allows a short spark, which is not uncomfortable, produces hyperemia and bathes the part in ozone, both of which are desirable.

To Relieve Pain.—The choice of a tube for the relief of pain should be one emitting a pinkish red fluorescence. The strength of the current should be such as will produce a counterirritant effect. Sparks should be avoided unless you desire a very prolonged effect as obtained from minute blisters.

Cauterization effects from a small pointed vacuum electrode are not unlike the ones from a fulguration electrode, heretofore mentioned. Small epitheliomas as well as all kinds of neoplasms of the skin and mucous membranes may be treated by small vacuum electrodes, with a current beneath the desiccation point, but will require several applications. This method is preferred by super-sensitive patients, as desiccation is more or less painful.

Nearly all treatments with vacuum electrodes are administered by the unipolar method, but if a more intense effect be desired the bipolar method may be used by connecting up the patient in the same manner as for diathermy, except that you employ a vacuum electrode for one of the poles instead of a metal electrode.

This method is known as local d'Arsonval application.

Auto-condensation.—The term auto-condensation, in itself, means that the patient himself forms a part of the condenser in the circuit of high-frequency current.

An auto-condensation couch consists of a metal plate attached to one pole of a high-frequency apparatus, on top of which is an insulating mattress upon which the patient lies. The insulating material may be of mica, glass, rubber, felt or cushion material. The other pole of the machine is held by both hands.

The plate underneath the mattress becomes one side of the condenser, similar to the inner coating of a Leyden jar, the patient becomes the other plate of the condenser, corresponding to the outer coating of the jar. The mattress forms the dielectric and corresponds to the glass of the Leyden jar. The current enters the plate on one side and sets up another current in the patient's body by induction and finds its exit through the electrode held in his hands. This arrangement condenses electricity in the patient's body and he undergoes many millions of oscillations. This produces profound effects upon the vasomotor mechanism which causes a reduction of blood-pressure, increased metabolism within the body, as well as increased elimination of the products of combustion and toxins.

A condenser couch may be made with separate plates connected to the diathermy terminals so that the current can either be given to the whole body or concentrated under special parts.

Autoconduction is another form of procedure to secure the same effects. In autoconduction there is another solenoid added to the d'Arsonval apparatus, which is made large enough for the patient to be placed therein. The difference between autoconduction and auto-condensation is that in auto-condensation the patient forms part of the condenser, while in autoconduction he forms part of the coil. Some operators favor autoconduction for reducing blood-pressure, but there is not enough dif-

ference in the effects to compensate one for giving it space.

Similar effects to autoconduction may be secured from a wire mattress heavily insulated on the side upon which the patient lies, and the connections made to each end of the mattress, the patient receiving the charge by induction.

The effects of auto-condensation will be explained at various times when we have under consideration treatments by this method.

Perhaps some time patients will experience a pricking sensation while under treatment by auto-condensation. This calls for more insulating material. A folded sheet placed on the pad or couch underneath the patient will relieve the situation.

If you have a machine, the dialectric of which is composed of paper, you are very liable to get faradic sparks. Do not touch your patient while under treatment by auto-condensation, for you, as well as your patient, might receive disagreeable shocks.

Whenever a patient coming from an auto-condensation treatment expresses a sensation of being tired, do not forget to prescribe a dose of castor oil to relieve him of the products of increased metabolism.

Local auto-condensation may be applied by interposing a dialectric of rubber or plate glass between the metal electrode and the part to be treated.

Indirect sparks are produced as follows: Place the patient on the couch or chair pad and connect it to one side of the machine, the operator holding an electrode which is grounded or connected to opposite side of machine. When the electrode approaches the patient to within sparking distance, sparks will be drawn from his body.

When using vacuum electrodes care should be exercised to prevent the connecting cord from touching the patient, as unpleasant sparks will result.

Contraindications.—In the beginning of practice with high-frequency currents the tendency is toward their indiscriminate use. It is as essential to know when *not to use* them as it is to know when *to use* them. In the chapters to follow, high-frequency currents will be recommended for many pathological conditions, and one might easily be led to believe their use to be almost unlimited.

It is here that I desire to offer a word of warning: A man's failures are more widely advertised than his successes. One serious accident, such as a hemorrhage from the lung or the "going out" of a case of arteriosclerosis, might seriously injure one's reputation.

We must not use the diathermic method if there is a recent history of hemorrhage. No matter where the hemorrhage be from, that place must be avoided. High-frequency has been highly recommended for pulmonary tuberculosis, and, indeed, it has proven itself to be of great service in properly selected cases. The diathermic method may be employed with benefit in some early cases, but if ulceration has taken place and cavities formed, great caution should be exercised as a disagreeable or perhaps fatal hemorrhage might occur.

This does not apply to pneumonia, for there is no tendency to hemorrhage in bronchial or lobar pneumonia. The unipolar application by vacuum tubes is not contraindicated in any stage of tuberculosis.

While papilloma of the bladder are easily destroyed by high-frequency cauterization, a most disagreeable hemorrhage might occur therefrom by application of high-frequency to the prostate.

Do not apply diathermy to any part of the pelvis if there has been recent bleeding. Do not employ it within twenty-four hours of the menstrual period. Pregnancy is a positive contraindication to its use below the waist-line.

Diathermy powerfully stimulates the secretion of glandular organs, consequently, do not apply it to the thyroid gland in cases of hyperthyroidism. Do not apply diathermy to tubercular glands, nor to any place where there is a collection of pus: The streptococci and staphylococci are increased by the stimulation and there might be a sufficient absorption to produce pyemia; therefore, diathermy is contraindicated in boils and carbuncles.

Never apply diathermy to an acutely infected joint. Do not apply it to a joint acutely affected by rheumatism.

If you possess a galvanic outfit try ionization of sodium salicylate. If you wish to use heat on a rheumatic joint try radiant light and heat.

If auto-condensation with 300 to 400 milliamperes produces faintness, vertigo, dyspnea, heavy sweating or sleeplessness, administer a dose of castor oil and repeat the treatment with 300 milliamperes; if the same symptoms occur again do not repeat it, but try diathermy to the affected organ.

In cases of advanced arteriosclerosis proceed with auto-condensation very cautiously until you are sure of no untoward result. A heavy current might cause a cerebral accident. Be very careful of the frail organs of the aged—they are extremely sensitive to any form of electricity.

However, we are consulted quite frequently by elderly patients suffering from cold limbs and stiff and crampy muscles. This condition is usually one of arteriosclerosis. Much can be done for these patients by diathermy, but



Fig 77.—Model "F" Thompson-Plaster cabinet.

weak currents must be used at first or we will make them worse. Apply the current directly to the crampy muscle, the electrodes being near to each other, and do not use the couch or chair until you are sure that heavier currents are required, then proceed with caution.

It is best to avoid diathermic currents to the sinuses of the head unless you have drainage, when special applications may be beneficial.

I have seen reports of brilliant results obtained from diathermy in appendicitis. In cases of appendicitis, provided we see the case before pus formation, I believe most cases may be aborted. If pus has formed diathermy might spread the infection and thus defeat us and prove unfortunate for the patient.

The revulsive effects from a vacuum electrode with unipolar attachment would be very beneficial in the first stage of appendicitis.

Be cautious about applications of diathermy to an infected gall-bladder. If there be drainage through the common duct great benefit would be expected. The same precautions apply as to an inflamed appendix.

I see no contraindication to unipolar applications when there is an elevation of temperature, but do not employ the auto-condensation method where there is a temperature of 100° F. or over.

The machine illustrated in Fig. 77 is of the Tesla type and delivers a current of high voltage and moderately high amperage. It is equipped with a set of four Leyden jars which gives to the current an oscillating character which is of considerable value in treatments by auto-condensation. It is also equipped with a multiple section spark-gap with tungsten points. All sections are perforated in such a manner as to permit of a free circulation of cool air directed through them from an air pump housed in the cabinet. The

spark-gap has a large opening from end to end to which is connected an air hose which carries cool air to all its parts during operation of the machine which keeps it cool and free from oxydizing products thus permitting of almost continual operation. The machine embraces the following



Fig. 78.—The Victor "Model Wantz" high frequency machine. This apparatus is of a new design furnishing two forms of high-frequency current. It is equipped with a new form of spark-gap which permits of long continued service without periods of rest for the purpose of cooling off. It is equipped with a closed core, oil immersed type of high tension transformer. This is a new innovation in the construction of high-frequency machines.

features: Compressed air, a nebulizing outfit for spraying, nebulizing and powder blowing, an electric heater for warming the sprays, an electric air heater for applying hot air to

the surface and cavities of the body, a compressed air vibrator with vibratodes, a suction apparatus for cleaning cavities and sinuses and inducing hyperemia in accordance with the Bier method, a set of vacuum cups, the usual set of vacuum electrodes, fulguration electrode, a diagnostic light controller with illuminator and lamps. It also has a cautery transformer and knives. This is an efficient machine for all kinds of work.

SINUSOIDAL.

Sinusoidal is a term applied to a current which starts at zero and gradually increases to its limit of strength and back again to zero, then to the opposite polarity in the same manner. In other words, the current, otherwise constant, is produced in an even sine wave.

This current is sometimes called a galvanic sinusoidal because the passing current is galvanic in character. There is a constant change of polarity, thus doing away with the electrolytic effect of the galvanic current, each positive phase being replaced by a negative one. The alternating current is also used in some types of sinusoidal apparatus.

Muscular contractions produced by a properly constructed apparatus closely resemble physiological ones, which makes the current agreeable. To be properly constructed an apparatus must be so arranged as to give slow, rapid and surging sinusoidal currents. It must also have facilities for complete control as well as a millimeter.

Currents from a sinusoidal apparatus are a distinct improvement over the currents from a faradic coil, and outside of the Bristow coil current, completely supplant them.

When both electrodes are placed on the abdomen congestion of the viscera is reduced.

The sinusoidal current is useful in eliciting the reflexes of Abrams, the technic of which is: Place one large wet electrode over the sacrum. The other electrode, which must have a device for interrupting the current, is



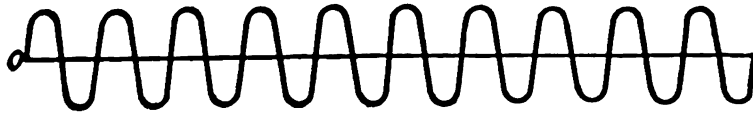
Fig. 79.—McIntosh No. 8 polysine generator presents a combination of galvanic and sinusoidal apparatus for operation upon an alternating current, and is equipped with an alternating induction motor which is connected to a generator which generates not only a galvanic current but a sinusoidal as well. It is so arranged as to give from 10 to 170 cycles per minute. It is fully equipped to deliver a variety of currents, as shown in Fig. 80.

applied to the spinous processes of the vertebræ. The visceral reflexes are elicited by interrupting the current which must be a strong one.

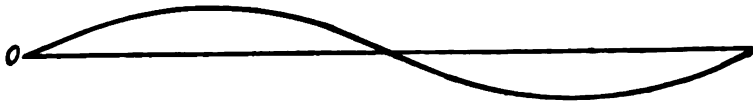
It is the current of choice in inducing analgesic effects whether superficial or deep seated. It is sometimes pos-

sible to secure muscular contraction with the sinusoidal after the faradic current fails in degenerative lesions.

A sinusoidal current will induce muscular contraction



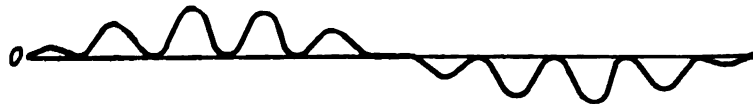
1. Rapid sinusoidal, 1800 cycles per minute.



2. Slow sinusoidal, 10 to 170 cycles per minute.



3. Surging sinusoidal, 20 to 380 cycles per minute.



4. Superimposed wave, 10 to 170 cycles per minute.



5. Combined galvanic and sinusoidal, 1800 cycles per minute.



6. Slow surging galvanic, 20 to 380 periods per minute.

Fig. 80.—Sinusoidal currents.

without the necessity of placing the electrode over motor points. By exercise of the muscles this current will eliminate toxic matter and consequently relieve *backaches* where toxins are the etiological factor. It is an exceed-

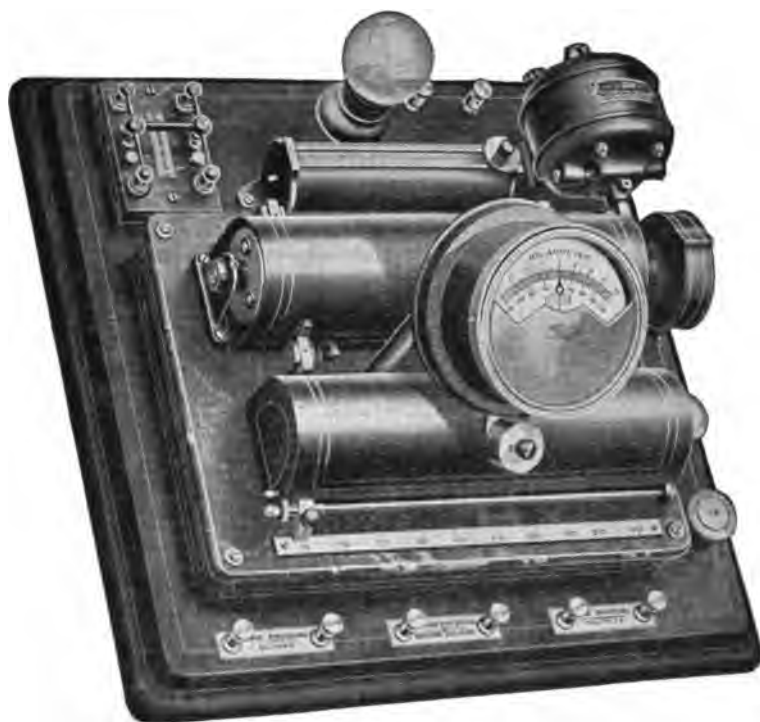


Fig. 81.—Victor multiplex sinusoidal apparatus. This apparatus is designed for operation on the direct current. If the alternating current only is available then it will be necessary to install a motor-generator set. This is an efficient apparatus where the direct current is available. It not only delivers a direct current but all gradations of the sinusoidal from slow to rapid.

ingly useful agent in restoring weakened muscles of the back, thus relieving backache from this source.

LATERAL CURVATURE.

Lateral curvature of the spine requires muscular exercise. Many movements which bring the weakened muscles into play may be made by the patient, but usually these exercises overdevelop the normal muscles and often increase the deformity. Here is where the sinusoidal current proves its usefulness. It develops the weakened muscles without overstimulating the normal ones or weakening the nervous force so often accompanying scoliosis. I never saw a chronic scoliosis benefited by a plaster jacket. While in acute cases it is often advisable it is never indicated in a chronic condition because it *always increases muscular atrophy*.

Muscular sinusoidalization increases the flow of lymph and blood; it hastens the absorption of exudates and separates adhesions, thus being useful in *stiffened joints*. In *cervico-brachial neuritis*, after the acuteness of the affection has passed, the sinusoidal current will be found useful. It is indicated in muscular atony anywhere, and especially in cases of *infantile paralysis*.

Flatfoot is often benefited by stimulation of the tibialis anticus with one electrode to the inner side of the knee, the other to the inner side of the foot.

The sinusoidal current with one electrode over the fourth and fifth cervical vertebræ, the other over the sacrum, will often relieve attacks of *bronchial asthma*. The static current also applied to the cervical vertebræ will often relieve asthmatic attacks.

The rectal and bladder troubles of the tabetic are often relieved by the sinusoidal current with one pole over the bladder, the other over the sacrum. Sometimes

better results are obtained with one electrode in the bladder.

Fatigue plays an important part in the efficiency of the human machine. It is a marked symptom in many impaired conditions. Outside of readily recognized diseases fatigue is a symptom of an asthenic neuro-circulatory condition, probably due to toxic material circulating in the blood. If this be present after a cleaning out of the food tube, an application of the sinusoidal current to the seventh cervical vertebra will often correct the condition.

INTESTINAL STASIS.

Every physician from the days of Hippocrates to the present time has recognized the rôle played by intestinal stasis in the etiology of many pathological conditions, which makes it one of the most important subjects before the medical profession. It may as well be said that with the aid of the physiologist, pathologist and bacteriologist we have made but little progress toward an understanding of this condition and its therapeutic management.

Intestinal stasis means a delay in the normal passage of the contents of the intestinal tract, the result of which is the formation of toxins which enter the general circulation and produce many untoward effects. These effects may be produced suddenly when there is a rapid absorption of a large amount of mild or a small amount of virulent toxins. The nervous system is profoundly affected by the presence of these poisons in the circulation, and after a time the nerve force becomes weakened and the tone of the intestinal musculature impaired.

Physiologists differ widely in their guesses on the muscular movements of the intestine; so much so, in fact, that it may be said that our knowledge concerning that

portion of the mechanism of man is very limited. The circular fibers of the intestine alternately contract and relax—how often and under what circumstances we are more less in the dark. The action of the longitudinal fibers is only to be conjectured. We do know, however, that the introduction of food into the stomach stimulates muscular activity of the gastro-intestinal system, which activity we are pleased to term “peristalsis.” Some physiologists claim that peristalsis is continuous during digestion, with alternate contraction and dilatation at the rate of about fifteen per minute. Others claim that the alternations are about four per minute, and still others that the action is irregular and that the movements depend upon the amount and character of the intestinal contents.

The want of understanding of the digestive process is the basis of the various onslaughts on this part of the human anatomy. We have not yet passed the period of empiricism in our treatment of gastro-intestinal disturbances.

What part is played by intestinal flora in constipation and diarrhea? What is the physiological action of the bile? Is there any definite knowledge of the part played by the spleen in digestion? We know that the spleen is a laboratory for all sorts of bacteria. It seems always to have on hand a complete stock of micro-organisms which are displayed in many blood conditions. The spleen is known to contract and dilate during the process of digestion, but just how it influences this important function is not known.

The liver is thought to be the mortuary of the toxins produced by albuminous putrefaction. It is supposed to bury the poisonous products or at least make them innocuous and to pass them along to be eliminated by the

kidneys, but when it fails, a line of symptoms appear, known to us as auto-intoxication.

When the digestive function becomes better known we will know more about intestinal stasis. When knowledge is absent the children of ignorance and superstition play havoc with the home. The quack and patent medicine vendor come along with nature's remedy tablets, liver pills, effervescing salts galore; the masseur with his squeeze; the osteopath and chiropractor with their adjustments; the homeopath with his dilutions; the regular with his calomel, jalap, epsom salts, castor oil, cascara, senna and paraffin oil; the proctologist with colonic flushings; the surgeon with his appendectomies, gastro-enterostomies, releasing kinks and suspension of ptosed viscera.

One dietitian recommends a diet which leaves but little residue and another recommends a diet which yields a rich residue. Health-talks preach on the advantages of a strictly vegetarian diet, again on excess fruit and still again on buttermilk and exercise. The hydropath advises enormous quantities of water and the patient gets fat and still is constipated. Others advise a four-mile hike and ten somersaults before breakfast. The gymnast hangs by his heels and rolls a cannon ball over the abdomen and still dreams of a water closet.

The poor suffering human after being treated and maltreated by some or all of these methods still prays for a natural evacuation. Man is the only animal who fails to answer the phone when nature calls. He is educated to thwart nature after his first year. He may be what is called a law-abiding citizen and may obey some of the laws of health, but compliance with the notices from his sewer department is usually neglected.

The mechanism of man is particularly adapted to care for itself during strikes and brain storms. It will stand more punishment with less complaint than any other machine.

It has been stated before that nearly all diseases arise from deranged metabolism, and intestinal stasis is responsible for a large proportion of the derangement. Intestinal stasis is followed by toxemias. Toxemia is a causative factor in hypertension. Hypertension is followed by cardiorenal disease, arteriosclerosis and cerebral accidents. In an effort to clear the intestinal canal of toxic products great quantities of blood are sent to the scene, the digestive organs are flooded and splanchnic neurasthenia is one of the results. Muscular efforts to clear the food tube force the abdominal contents downward producing a condition known as enteroptosis. This condition is usually accompanied with adhesions and appendicitis. A little physiological plumbing is preferable to cutting the system out. Operations are frequently followed by more adhesions and more intestinal stasis; the patient becomes a hopeless neurasthenic and drifts from one physician to another, to the osteopath, the chiropractor and finally settles down to physic, petroleum and prayer.

Atonic constipation is followed by dilatation of the intestines recognized by pot-belly appearance and tympanic sound on percussion. The common form of constipation is atonic. Spastic constipation occurs less frequently and is easily recognized by palpation of the abdomen during which the contractions may be felt. Contracted intestinal segments can be made out by percussion. This form is usually aggravated by cathartics.

A person may have a bowel movement daily and yet be constipated. If a dose of bismuth, which blackens the

feces, does not begin to pass within twenty-four hours, constipation is present. In treatment of these cases we all recognize the beneficial effects of habit. If established in early life, a habit of going to stool at a stated time (usually after the morning meal) will prevent many cases of intestinal stasis. While preventive medicine is rapidly coming into its own, we, as yet, are unable to treat our patient's grandfather, consequently our patients suffer from the effects of constipation. We all have had our experience with cathartics, and outside of temporary relief, have usually found them wanting.

The electrotherapist has no corner on knowledge of the digestive function, but he believes that the central nervous system controls all movements of the intestines through the vagus and splanchnic nerves, and that an enfeebled nervous system is the prime factor in all motor disturbances of the gastro-intestinal tract; consequently his treatment is directed to the restoration of the nervous function. The better the understanding of the controlling factors of the nervous system, the better will be the results of treatment. When the sympathetic is stimulated the secretory and motor activities of the gastro-intestinal tract are inhibited.

Psychic and nervous influences are oftentimes the controlling factors in many, and, I might say, most circulatory and digestive diseases. If at any time you are in doubt about this being true, subject these diseases to a vigorous treatment of the nervous system. The sympathetic nervous system is the controlling factor in the functional activity of our vegetative system, and the more these diseases are treated by medical and diatetic methods the more you will be convinced of this fact.

Even though the condition of the nervous system be the result rather than the cause of the enfeebled muscular

tone of the intestine, the treatment to restore the tone is indicated.

The sinusoidal current is the only modality that will contract and dilate the muscular fibers of the intestine in a manner simulating nature. When increased gastric tone is desired, place one electrode over the second and third lumbar vertebræ, the other over the space at the left of the ensiform cartilage and turn on a current strength of from 100 to 200 milliamperes, using a wave that reaches its height from 15 to 18 times per minute. Time of treatment fifteen minutes.

Practically all cases in the primary stage of intestinal stasis and enteroptosis can be cured by the proper application of the sinusoidal current, and every case not accompanied with purulent infection can be benefited.

We employ a sine wave with about fifteen alternations per minute because we believe this to be about the normal rate of intestinal contraction. In intestinal stasis apply one electrode over the lumbar region, the other at different points over the abdomen.

In the spastic form of constipation apply one electrode over the lower dorsal vertebræ, the other over different points of the colon. The object is to relieve spasm. The same effect may be secured by applying one electrode over the sacrum, the other over the eleventh dorsal. This is the method employed by Abrams.

A combination of these treatments will relieve many cases of splanchnoptosis. It is a procedure which yields far better results than splanchnotomic surgery.

INDICANURIA.

At one time considerable significance was given to the presence of indican in the urine. While it is true that indican in the urine may result from the absorption of

products of proteid putrefaction in the intestine, there are many other conditions accompanied by indicanuria. It may come from decomposition of albumen elsewhere in the body than the bowel. It may be present in pulmonary tuberculosis, empyema or purulent bronchitis. It may also be found in the urine of patients suffering from appendicitis, typhoid fever and in intestinal carcinoma as well as many other conditions.

In cases where there is no indication of other diseases than constipation or diarrhea and we find indican in the urine, we may be reasonably sure of intestinal toxemia. Indican in large quantities in the urine may impart to it a deep brown color which may be mistaken for blood, but the ordinary indican test will differentiate it.

Dr. Abrams says: "If one electrode of a sinusoidal current is placed over the sacrum and the other over the spine of the first three lumbar vertebræ it will promote the excretion of indican in the urine." This statement bears out what has been said about the treatment of cases of intestinal stasis by the sinusoidal current.

Bearing in mind what has been stated in regard to the effects of the sinusoidal current it will easily be understood that it is indicated in the management of many conditions not mentioned.

In applying sinusoidal electrodes to the abdomen it is well to bear in mind the location of nodes of the mesenteric plexus. The nodes according to Keith are located at the cardiac and pyloric ends of the stomach, the third portion of the duodenum, junction of jejunum and ilium, lower extremity of ilium and the distal colon. Keith believes that these nodes of the plexus regulate the rhythm of intestinal contraction. Whether or not this be true it will be noted that we secure better results when we direct our sinusoidal application to these points.

We often find in these cases an engorged liver with a secondary effect of enlargement of the right heart. A few applications of diathermy to the liver and heart will greatly improve the picture.

CHAPTER VI.

BLOOD-PRESSURE.

Physiology. Arteriosclerosis. Effects of drugs. The sphygmomanometer. Methods of taking blood-pressure. Phases. Taking blood-pressure by the fractional method. Normal blood-pressure. Pulse-pressure. Blood-pressure in surgery. Typhoid. Tuberculosis. Pneumonia. Neurasthenia. Menopause. Obstetrics. Hypotension. Metabolism.

THE circulation of the blood serves a twofold purpose: (1) As a distributor of nutrition to the tissues; (2) a conveyor of effete products of metabolism.

In considering blood-pressure two questions present themselves: (1) What causes the blood to circulate? (2) How can the pressure be changed? Then occurs to our minds: What is a normal blood-pressure and how can it be ascertained? How may we know the physiological limits of blood-pressure so as to be able to understand when it becomes pathological? If pathological, its cause and probable results? If it be too high, how can it be reduced; and if too low, how may it be raised? What are the end results of a continuous high blood-pressure and how may these results be avoided? An attempt will be made to answer these questions in accordance with our understanding of the physiology of the circulation.

PHYSIOLOGY.

It is well to bear in mind that the general conditions governing the blood-flow through the circulatory system are the same as those governing the flow of fluid through any system of tubes. The rate of flow from any such system depends upon two essential factors: (1) The head

and end pressure of the system; (2) the caliber of the tube at the outlet. Raising the head pressure will increase the flow with the caliber of the outlet remaining the same, or we may increase the flow by increasing the caliber of the outlet.

The circulation of the blood is maintained by pressure given by the heart and the resistance offered by constriction and dilatation of the blood-vessels. In order to understand how the normal blood-pressure is maintained as well as how it is varied, it is necessary to study the mechanism of the heart-beat and the nature of the control of the blood-vessels. Blood-pressure in the same sized arteries varies but little in the different mammals. According to Macleod the pressure in the carotid artery of the dog averages 110 to 120 mm. of Hg.; in that of the cat 105 to 115; in the rabbit 90 to 105; in the sheep 150; in the horse about 200 and in man 120 to 140 mm. of Hg. The systolic pressure varies in different parts of the arterial tree, the greatest being in the aorta and the least in the smallest arterioles. The pressure in the femoral or renal artery is very little less than that of the aorta. The diastolic pressure remains about the same throughout the arterial system. The diastolic pressure is of considerable importance because it advises us of the constant pressure load on the aortic valves.

Blood-pressure depends upon five factors:

1. Heart force.
2. End resistance.
3. Elasticity of vessel walls.
4. Amount of blood.
5. Viscosity of the blood.

Heart Force.—It is probable that the heart beat originates in the sino-auricular node, the wave passing over the auricles until it reaches the auriculo-ventricular node

or bundle of His, which starts the impulse in the ventricle. It is yet undecided whether the path is direct from the auricle to the ventricles or the impulse spreads from two distinct paths. This, however, is immaterial in this consideration (Fig. 82).

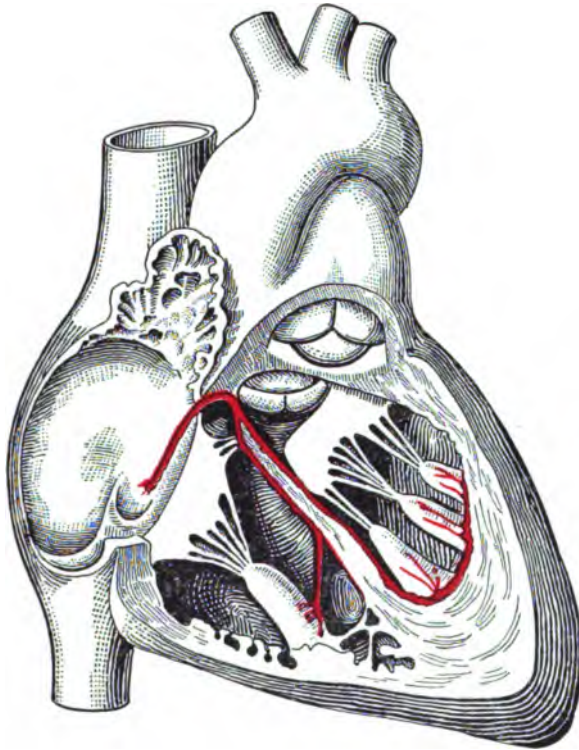


Fig. 82.—Heart nodes. Bundle of His.

The heart beat in its relation to blood-pressure is both physiological and mechanical. Mechanically speaking the heart is a pump and as such is responsible for the head-pressure of the blood. Physiologically the nerve supply of the heart has much, if not all, to do with keeping up

its action. The rapidity and force of the heart beat are regulated by the vagus nerve. A complete inhibition of the vagus will cause a rise in blood-pressure. A partial inhibition of the vagus will cause a fall in blood-pressure. A stimulation of the peripheral end of the vagus will cause a fall in blood-pressure on account of its action of slowing and weakening the heart beat.

End Resistance.—The most important question to consider in heart disease is: Does the heart muscle receive sufficient blood supply for the purpose of nutrition? The heart muscle receives its blood supply primarily from the coronary arteries. The blood is driven into these arteries with every heart systole. During diastole the cardiac vessels suck the blood from the coronary arteries; it then passes through the capillaries where it gives up the substances required for the proper nutrition of the heart.

As the knowledge of heart physiology increases, the greater is our respect for the vagus and other reflex control. The heart receives all its nervous stimuli during diastolic pause. During systole the heart is firmly contracted and is unaffected by irritation from any source, so in one sense the efficiency of the heart is in ratio to the length of diastolic pause. When a heart begins to lose its efficiency from contracted valves, the number of systoles increases in order to supply the call of the body for blood. When the heart increases its beat the diastolic pause is necessarily decreased, hence the nutrition of the heart is impaired. What we want to do in conditions of this kind is to assist the vagus in slowing the heart, thus increasing the diastolic pause. If unable to secure these results through the vagus we seek assistance from other nerves through reflex action (Fig. 83).

The rapidity and force of the heart beat are regulated by the vagus nerve. A stimulation of this nerve inhibits

the heart and a stimulation of the sympathetic accelerates it. The innervation and enervation of these nerves, from many causes, produce varied actions of the heart. The pulse may be stopped by pressure on the vagus in the neck. I have reduced a heart beat of 150 to 70 by ap-

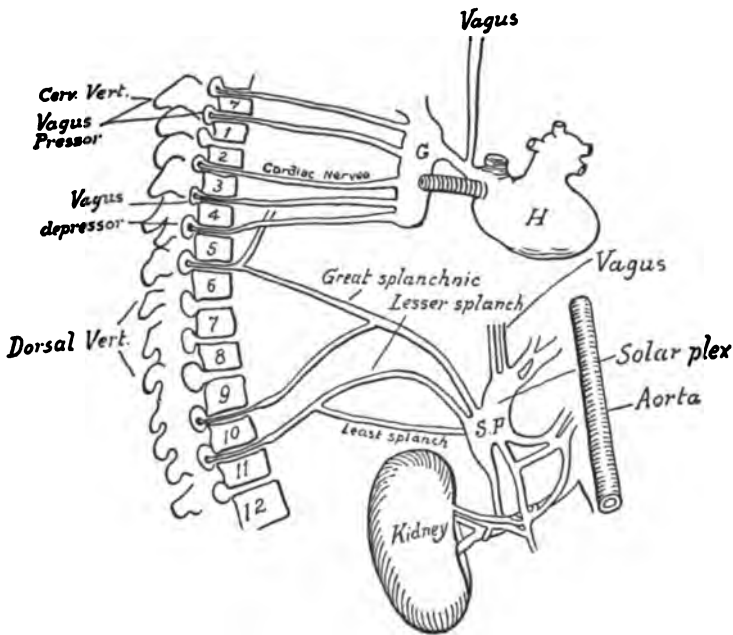


Fig. 83.—Diagram of origin of cardiac and splanchnic nerves.

plication of the galvanic current to the vagus which lies adjacent to the carotid artery in the neck. Want of vagus tone will cause palpitation, arrhythmia and tachycardia. Whenever the vagus fails, its opponent (the sympathetic) steps in and does the work, but in the opposite direction. According to Abrams the heart may be inhibited by reflex action through the spinal nerves. While I am not able to elicit all the phenomena of contraction and dila-

tation according to the Abrams method, I have been able to do so in certain cases. I have positively proven in many cases of heart acceleration that its action may be steadied by percussion of the seventh cervical vertebra, friction of the skin over the precordial region, percussion of the chest over the heart, high-frequency vacuum current on either side of the seventh cervical vertebra and sinusoidal current over the precordial region. These maneuvers subdue the vagus reflex by a counter reflex. All these means of eliciting reflexes have been pointed out by Abrams. Vasomotor nerves have pressor and depressor fibers. When the pressor fibers are stimulated, blood-pressure rises by increasing end resistance. Stimulation of the depressors causes a fall in blood-pressure by dilatation of the arterioles which lowers end or peripheral resistance (Fig. 84).

Toxins circulating in the blood irritate the pressor fibers which cause a contraction of arterioles, thus increasing end resistance. The heart under such conditions has an increased amount of blood to work upon and the ventricles are compelled to increase force in order to overcome the resistance. When the heart has been called upon for some time to do extra work, the result here, as elsewhere in muscular exercise, is growth of muscle, which we are pleased to call hypertrophy. This condition may exist for weeks, months and even years, but sometime in the course of events the muscle fails and is unable to squeeze out the contents of the ventricles, the heart muscles become fatigued from overwork and gradual intoxication and relax their efforts; the hypertrophy gradually becomes less and less, the muscles relax or let go, as it were; the heart walls become thin, while pressure from within and resistance to overcome from without so weaken the muscles that they can no longer empty

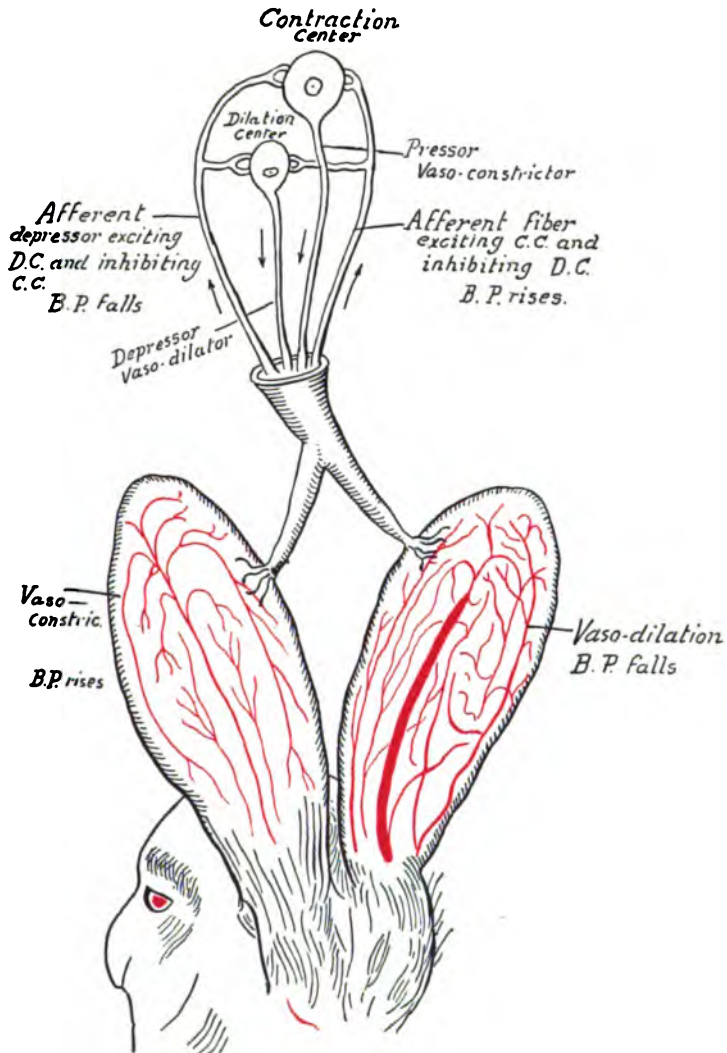


Fig. 84.—Diagram showing effects of pressor and depressor fibers of nerves on blood-pressure.

the ventricles, thus leaving a quantity of blood in the ventricles after each systole. When this condition prevails hypertension decreases to normal which is soon followed by hypotension, myocardial weakness, cardiac delirium and cessation of work altogether.

The vasomotor mechanism is responsible for normal blood-pressure regulation. When the volume of blood diminishes, contraction of the arterioles takes place to regulate the pressure. When the amount of blood is increased the arterioles dilate allowing more blood to escape into the veins and splanchnic area, thus equalizing the circulation which keeps the pressure normal.

Emotional influences play an important rôle in vasomotor control, the pressor nerve fibers are stimulated, the arterioles are contracted, the pressure rises. This may be followed by depressor action and the blood-pressure falls often below normal before the mechanism is able to readjust itself. This is the stage of exhaustion or possible collapse often seen in persons of oversensitive nervous system. In cases of neurasthenia the depressors are working overtime, the splanchnic area is continuously flooded, thus draining the arterial side of the circulatory system, leaving a lessened amount of blood for the heart to work upon and a consequent lowering of pressure. This is a part, only, of the picture of neurasthenia. Many other nervous phenomena assist in keeping the pressure below normal in these cases. The vagus and sympathetic which maintain normal conditions become insane—sometimes one, sometimes the other in supreme command. When the vagus goes on a strike the sympathetic commands the situation, the heart runs riot and *vice versa*. Intellectual application exerts a stimulating effect upon the pressor fibers which is evidenced by increased blood-pressure. Sleep and repose have a sooth-

ing effect upon the pressors, the depressors assume control and the pressure falls. Muscular exertion stimulates the ventricles of the heart to increased activity while the arterioles are more or less contracted, resulting in a rise of blood-pressure. This is followed by a relaxation of the arterioles, blood escapes into the splanchnic area, the heart has less work to do and the pressure falls. It is well to remember that the splanchnic area is capable of holding the entire amount of the body's blood. The liver alone may hold one-fourth of the blood of the body. Whenever we are bled into our splanchnic area it is easy to understand that there is little blood for the heart to work upon and the pressure falls. The effects of bleeding into our splanchnic area are the same, for the time being, as the effects of venesection.

Arteriosclerosis and hypertension are usually associated in our minds, but there may be thickening of the arteries with no elevation of blood-pressure. The heart muscle may be so weakened that a condition of hypotension exists. Arterial disease may be local or general. Janeway says: "The small arteries of the splanchnic circulation may be the seat of arterial changes and cause hypertension."

Pains from this disease are caused by vasoconstriction and are often relieved by drugs which cause vasodilation.

EFFECTS OF DRUGS.

The effects of drug vasodilators are at most only temporary. Autocondensation effects are more lasting. Certain drugs like strychnine, adrenalin and digitalis enjoy a reputation of being vasoconstrictors. Digitalis stimulates the vagus and to a certain extent blocks the auriculo-ventricular stimulation of the heart, and as a consequence the ventricles are slower to contract and a more or

less uniform rhythm results. Digitalis, by its vasoconstrictor influence on the arteries of the heart, may interfere with its nutrition. I have never been able to discern any increase in blood-pressure in persons taking digitalis. It never interferes in the reduction of blood-pressure by auto-condensation. If strychnine is a cardiac tonic in any sense, its beneficial action is due to its toning influence on the vasomotor mechanism. Neither of these drugs, in my hands, has been of any avail in any case of hypotension. Caffeine, the active principle of coffee, will raise blood-pressure in the norm 5 to 10 mm. of Hg., but fails to be of any permanent benefit in cases of hypotension.

In cases of neurasthenia there is usually a lack of adrenal secretion and possibly a dysfunction of all the ductless glands. Until the time comes when we understand the physiology of the ductless glands, pluriglandular therapy will be empirical.

While theoretically adrenalin is indicated in these cases it is of little use in practice. The different formulas of mixed glands are of real value in some cases, but we cannot determine beforehand the proper combination for each individual case, hence their use is experimental. If the combination happens to hit the case in hand the results are beneficial. They seldom do harm, so their use is justifiable.

Belladonna is known to be an antispasmodic and a partial vasodilator and theoretically should reduce blood-pressure but recent investigation has proven this doubtful. It quickens the pulse by its depressive, and if pushed by large doses produces paralytic action on the vagus. It dilates the blood-vessels of the skin and at the same time contracts the splanchnic vessels which prevents the fall in pressure. In poisonous doses it causes a fall in blood-pressure due to vasomotor palsy. In shock the

splanchnic vessels are in a state of relaxation, and belladonna, by its action of constriction of these vessels, becomes a timely remedy. You will pardon this departure into materia medica, it being only to disabuse your minds of the supposed benefit to be derived by the administration of belladonna in cases of hypertension. I have referred to me for treatment many cases of hypertension who are taking atropine or tincture of belladonna prescribed by their physicians for the purpose of lowering blood-pressure. Belladonna is one of the most useful drugs in the practice of medicine, but not unlike electricity, it should be employed with a definite idea of its action. It may be useful in some cases of hypertension, but it does not lower blood-pressure except when given in poisonous doses.

Sodium nitrite and nitroglycerin reduce arterial tension through their action on the vasomotor nerves by stimulating the depressor fibers which cause vasodilatation. The diuretic action of the nitrites is due to vaso relaxation. The effects of nitroglycerin in reducing arterial tension are evanescent. In alarming cerebral conditions and angina pectoris it serves an admirable purpose as a first aid measure. I have seen 1/50 grain of nitroglycerin placed on the tongue reduce the pressure 50 mm. of Hg. in two minutes, but the blood-pressure reached its former height in twenty minutes. The effects of sodium nitrite are more lasting, requiring three to four hours for the pressure to return. The use of these remedies is justified as first-aid agents, but their continued use to reduce and hold arterial tension is to be condemned.

Potassium iodide is a remedy worked overtime in hypertension. As a general proposition when the physician becomes weary of the nitrites he takes a long rest by prescribing potassium iodide which has yielded a sufficient

number of good results in hypertensive cases to justify its use. There are two reasons why it may reduce arterial tension, and they are bound up in the physiological action of the two elements of the combination—iodine and potassium. Potassium acts as a vasomotor depressant, and when taken in fairly large doses reduces arterial tension by its antispasmodic effects. We know but little about the physiological action of iodine, but we do know that it exercises a profound influence over nutrition. This is said to be due to its alterative action. This may be explained when we are able to define the word “alterative.”

There are many cases of hidden syphilitic infection which proves to be a factor in hypertension and the patient is relieved by iodine in proportion to the degree of infection, otherwise the relief afforded by potassium iodide in cases of hypertension is due to the potassium content. The benefit derived from KI in some cases of nephritis is due to the vasodilator properties of the potassium. More satisfactory and lasting results in hypertension may be obtained from diathermic and auto-condensation currents than from any or all the drugs just mentioned.

Elasticity of Vessel Walls.—Elasticity of the walls of the blood-vessels plays an important rôle in the control of blood-pressure. If the walls of the vessels were unyielding the pressure would become *nil* between each beat of the heart. It is therefore important that some means of maintaining the pressure be supplied, and this is found in the elasticity of the vessel wall. The force of the heart-beat produces a wave of pressure which travels throughout the arterial system. When the pressure of the pump ceases, the vessel walls, already placed upon a stretch, recoil on the blood and maintain the pressure. Of course, there is a momentary fall between the heart-beats which may be easily recognized by watching the oscillations of

the needle or mercury column of the sphygmomanometer. Theoretically the diastolic pressure of a hardened artery should be lower than normal. This, however, is not the case. The explanation of this condition is found in the end resistance which is almost always constant in cases of arteriosclerosis. A continued hypertension diminishes the elasticity of the arterial wall, then dilatation is likely to follow, producing aneurism, or the wall may rupture as in cerebral hemorrhage.

Amount of Blood.—The amount of blood in the body is an important factor in the maintenance of circulation and consequent pressure. The normal amount of blood constitutes from 5 to 7 per cent. of the weight of the body. The effect of a sudden abstraction of blood from the body, as in a hemorrhage, depends upon the rate of bleeding. If you cut a small hole in your garden hose the effect upon the pressure at the outlet will not be materially effected until the amount of water at the source or head pressure is reduced. On the other hand, if a large hole be cut in the hose it will be found to at once reduce the flow at the outlet. The same principle is involved in cutting a blood-vessel. If a small one be cut it will not effect the pressure until a material lessening of the total amount of the blood takes place. On the other hand, if a large blood-vessel be cut there is a gradual fall in pressure because the head pressure is lessened and the end resistance lowered.

Macleod states that the removal of 5 c.c. of blood per kilogram of body weight does not influence the blood-pressure; that the removal of the second 5 c.c. causes the pressure to begin to fall; that the fall of pressure for each subsequent 5 c.c. is followed by a fall of about 6 mm. of Hg. until after 20 to 25 c.c. of blood per kilogram of body weight has been removed, when a rapid fall in pres-

sure sets in. The danger line is when the pressure reaches from 20 to 30 mm. of Hg., at which point the symptoms of shock supervene making recovery uncertain. The gradual loss of blood in hemorrhage is compensated for by vasoconstriction, and vasoconstriction is continuous until the blood quantity is reduced to a point below compatibility with life. The chances for recovery after a rapid lowering of blood volume depend upon the amount lost. Recovery is to be looked for if not more than 3 per cent. of the body weight is lost. The specific gravity of the blood is lowered by hemorrhage, due to the osmosis of the fluid from the tissues. In severe hemorrhages the blood becomes so diluted that hemolysis occurs. There is a great loss of hemoglobin content which may be recovered from the bone marrow. After hemorrhage recovery is hastened by feeding of flesh and gelatin. Transfusion of blood, saline solution or saline solution rendered slightly viscid with gelatin may be necessary. Transfusion of blood will raise and maintain the blood-pressure better than saline solution. The body will care for enormous quantities of saline solution, due to osmosis into the tissues and cavities of the body.

In order to prevent excessive blood-pressure nature has provided a protective mechanism in that when the peripheral resistance is increased the volume output of the ventricle is diminished.

Viscosity of the Blood.—It is a well known fact that the flow of a fluid through a tube is inversely proportional to the viscosity of the fluid. Allowing the head pressure to be constant the flow through the tube will be increased by reduction of the viscosity of the fluid. This may be easily demonstrated by an ordinary piston syringe. The pressure on the piston of a syringe with a water content will cause it to flow easily, when with the

same pressure exerted on a viscid fluid the flow will be decreased. In case of a hemorrhage if a solution of the same viscosity of the blood be injected, the effects upon the blood-pressure will be the same as if blood itself had been transfused; but when saline solution is injected its effect upon the blood-pressure will be immaterial because of the loss of the solution through the osmotic process. There are other factors which enter into the etiology of blood-pressure, but they are of minor importance.

The rate of the blood flow affects the blood-pressure to a certain extent, but this will not be considered at the present time.

Vasomotor Control.—All vasoconstrictor fibers emanate from the spinal cord between the second thoracic and the second lumbar spinal roots. Their origin is in the anterior spinal roots. After passing out they unite with fibers of the sympathetic and follow to their ultimate distribution. In their course they come into contact with ganglia of the sympathetic forming a synapsis around one of the ganglionic nerve cells. The fibers supplying the head arise from the second to the fourth thoracic roots. The fibers which are distributed to the vessels of the arms come from the fourth to the tenth thoracic roots and those from the lower limbs from the lower thoracic to the third and fourth lumbar roots.

The vasoconstrictors to the abdominal viscera are carried by the splanchnic nerves, the fibers of which come off from the lower seven thoracic and the upper lumbar roots. These fibers pass along the sympathetic chain until they reach the great splanchnic nerves which they follow. The lumbar fibers follow the lesser splanchnic nerves and finally reach the suprarenal glands accompanied by a branch of the greater splanchnic and the vagus from the celiac ganglion (Fig. 83).

The course of the vasodilator nerves is entirely different from that of the vasoconstrictors. The peripheral sensory nerves are rich in dilator fibers. There are many depressor fibers which have no central origin but accompany the sensory fibers to the blood-vessels and are lost, while other fibers of the same nerve run to receptor organs. The stimulation of these depressor fibers causes local hyperemia without action of the cerebro-spinal centers.

Vasodilator impulses may be transmitted by fibers arising from any part of the cerebrospinal axis and not only by motor roots but sensory as well. The dilator fiber supplying the lower limbs passes from the spinal cord in the posterior sacral roots. The sensory nerves of the rectum and genitalia are rich in vasodilator fibers. A dilatation of the rectal sphincter will through excitation of these fibers often reduce blood-pressure.

The vasodilator or depressor fibers which supply the abdominal viscera come from the posterior roots of the spinal cord and are transmitted with the splanchnic nerves, the reflex action of which may be invoked by stimulation of these fibers which are reached through the 11th and 12th spinal vertebræ (Fig. 83). Outside of any connection with the spinal cord there seems to be an independent tone of blood-vessels which is probably acquired from the suprarenal glands.

THE SPHYGMOMANOMETER.

Fifty years ago the clinical thermometer, the stethoscope and the hypodermic syringe were but little used by the general practitioner but now are the essentials of every physician's bag. Only within the last ten years have the measurements of pressures of blood been esteemed of practical importance. Now, the physician who

does not possess a reliable sphygmomanometer is on par with the man without a clinical thermometer. The sphygmomanometer is to the physician what the steam gauge is to the engineer and the mariner's compass to the captain of the boat.

As an assistant to the diagnosis of human ailments I would place the sphygmomanometer far ahead of the clinical thermometer in usefulness. It is equally important to the clinician and the surgeon. The surgeon who fails to determine the state of circulatory stress prior to an operation is as remiss in his duty as the clinician who tries to arrive at a satisfactory diagnosis without this valuable information.

He who thinks he can by palpating the radial artery even approximate the blood-pressure is at as great a disadvantage as he who estimates the temperature of the body by the frequency of the pulse.

Forty years ago blood-pressure was measured by an instrument not altogether different from the mercury column sphygmomanometers of today. It was called a cardiometer and its use confined to the laboratory. The relation of arterial tension to pathological conditions had not been worked out and probably had not even been thought of.

There are practically but two types of sphygmomanometers—one a column of mercury and the other built upon the principle of the aneroid, both of which record the pressures in millimeters of mercury. The disadvantages of the mercury column type are so many that they make it an instrument of little value. The principal disadvantage is that the action of the mercury is too slow to correctly record the diastolic pressure, the knowledge of which is absolutely necessary to determine the amount of heart load your patient is carrying.

METHODS OF TAKING BLOOD-PRESSURE.

There are two methods of taking blood-pressure—by palpation and by auscultation. The former method is now almost obsolete; the latter is the one of choice on account of its accuracy. A brief description of the technic of this method may not be out of place at this time:

The brachial artery of the left arm is usually the one of choice. All constricting clothing should be removed from the arm which should be relaxed and at ease, supported on a table, whether the recumbent or sitting posture be chosen. Apply the manometer sleeve to the arm above the elbow, making sure that it does not impinge upon the elbow joint; do not wind it too tight nor too loose; place the stethoscope over the brachial artery just below the sleeve; inflate the sleeve until at least ten points above the point where all sound ceases is recorded, then allow the air to escape very slowly until the first sound becomes audible. The point registered on the dial will be the systolic pressure. Slightly open the valve and watch for the point where all sound is lost: This will be the diastolic pressure. The difference between the systolic and diastolic pressures is the pulse pressure.

Phases.—In a normal individual four distinct phases of sound will be audible: (1) Beginning with the first audible sound which is sharp and distinct; (2) during which the sound becomes somewhat muffled; (3) more like the first; (4) becomes very soft and soon inaudible. Some clinicians mark the diastolic pressure at the point where the third phase is merged into the fourth, but the majority mark the point of diastolic pressure at the close of the fourth phase. It is always well to check your readings by repeating the test.

Taking Blood-pressure by the Fractional Method—In cases with auricular fibrillation and extra systoles, the

ordinary method of taking blood-pressure does not give accurate results. In these cases it is advisable to use the fractional method, the technic of which is as follows: The apex beat and the radial beat are counted for one full minute. Proceed to take the systolic pressure in the ordinary manner; release cuff pressure to zero, then increase the cuff pressure until reading is 10 mm. lower than the first reading and count the radial pulse and record it; repeat at 10 mm. intervals until the cuff pressure fails to cut off radial waves or when the pulse rate reaches the point before the cuff was applied. From these figures the average systolic pressure is obtained by multiplying the number of radial beats by the reading on the sphygmomanometer at the different points; add these products and divide the sum by the number of apex beats per minute. The result will be the average systolic pressure.

EXAMPLE.

Apex beat 120.		Radial beat 100.	
Blood-pressure.	Radial count.		
100	0		
90	15	$= 15 \times 90 =$	1350
80	40	$— 15 = 25 \times 80 =$	2000
70	70	$— 40 = 30 \times 70 =$	2100
60	100	$— 70 = 30 \times 60 =$	1800
			<hr/>
		Apex 120)	7250
			<hr/>
		Average systolic	60+

The normal limits of blood-pressure vary in accordance with the following conditions, viz.:

1. *Position of the Body*.—About 4 mm. higher when standing than sitting. About 4 mm. lower in the recumbent than in sitting position.

2. *Muscular Exertion*.—Higher immediately after exercise but should assume normal within five minutes.

Lower after extreme exertion producing fatigue, but should return to normal within one hour.

3. *Excitement, Anger, Passion, Etc.*—A sudden rise but soon returns to normal.

4. *Time of Day.*—Lower in the forenoon than afternoon.

5. *Digestion.*—A fall of about 10 mm. after a meal is usual. A rise of 10 to 15 mm. after a strong cup of coffee. The normal is reached in about one hour after meals when a slight rise will be noticed.

6. *Locality.*—There is usually a difference of about 4 mm. between the right and left side arteries, also between the femoral and brachial arteries.

A difference will also be found between the pressures in a fat and a lean arm.

Points to be Observed.—In taking readings on the same patient over a period of time, it is important to take them as near the same time of day, the same time from a meal and under conditions as nearly alike as possible.

During the first examination the readings should be taken in the horizontal and erect as well as sitting position. If in these readings the normal pressure is found to be reversed, an accumulation of blood in the splanchnic area is indicated. With a normal heart the pulse pressure will be found to fall in changing from the horizontal to the erect position. If there should be a rise you probably have a case of cardiac hypertrophy. The diastolic pressure may or may not be changed.

In cases of cardiac dilatation you will find a fall in the systolic, diastolic and pulse pressures in changing from the recumbent to the erect position. You will also find in this connection an increase in cardiac dulness, small feeble and rapid pulse with or without arrhythmia, also

an increase in size of the heart shadow on the fluorescent screen. This is also the case in cardiac hypertrophy.

A warm bath usually raises the systolic pressure but a hot bath followed by perspiration will lower it. A cold plunge suddenly raises the pressure. Persons with hypertension should be warned that the sudden rise due to a cold plunge might prove disastrous to the heart.

In failing heart with mitral stenosis with clinical data such as arrhythmia, dyspnea and general anasarca, the pulse pressure may exceed the diastolic. It is unnecessary to state that such cases soon succumb.

A high diastolic pressure shows great vascular tension and when constant indicates kidney involvement and possible cerebral accident. In streptococcic and septic conditions all pressures are usually low. Contrary to first thought in cases of hemorrhage a progressive decline in pulse pressure indicates a continuance of the hemorrhage. This is probably due to the reduction of peripheral resistance occasioned by sudden withdrawal of blood. Do not forget that the systolic pressure is easily influenced by physiological factors while the diastolic is not so easily influenced.

Some are accustomed to call cases of hypertension "idiopathic" when no cardiac or renal cause can be found. Idiopathic is a high-sounding term for "I don't know." These cases come under the classification of hyperpiesia, which will be considered later.

NORMAL BLOOD-PRESSURE.

Many tests have been made to establish a normal blood-pressure. There is no hard and fast rule, and we can but approximate the normal point of blood-pressure.

What seems to me to be one of the best studies for arriving at a normal blood-pressure was made of 500 soldiers in the American Army Aviation Service who

were considered normal subjects. The average age of these 500 men was 24 years; their average pulse rate 85; their average systolic pressure 127; their average diastolic pressure 84 and pulse pressure 43.

The averages of these men were also taken after exercise which consisted of running up a flight of twenty-four stairs, each having a six-inch raise. The results were as follows: Pulse rate 112, systolic pressure 145, diastolic pressure 90, pulse pressure 55. The average time of recovery to point before taking exercise was 4.4 minutes.

Faught says: "The pulse pressure, the diastolic and systolic pressures should stand to each other as 1, 2, 3, viz.: systolic 120, diastolic 80 and pulse pressure 40." This ratio is practically confirmed by the test on normal men of the Aviation Corps previously mentioned. You will find this to be a safe guide in practice.

While different observers make tables of their own and they all vary somewhat, you will find the following one to be practical and safe:

TABLE OF SYSTOLIC BLOOD-PRESSURE AT DIFFERENT AGES.

Children from 10 to 17 years of age	80 to 110
Adults " 20 " 30 " " "	120 " 125
" " 30 " 40 " " "	120 " 130
" " 40 " 50 " " "	125 " 135
" " 50 " 60 " " "	130 " 140
" " 60 " 70 " " "	135 " 145
" " 70 " 80 " " "	140 " 150

Females 10 mm. lower for same ages.

It is apparent that as one grows older the wear and tear upon the circulatory system produce vascular changes and that a man of 65 years of age may have a systolic pressure of 150, possibly 160, and be in fairly good health. It is of considerable importance, however, to remember that a sustained systolic pressure of over 150

at any age is always pathological, and that a sustained diastolic pressure of 105 or more, at any age, is also pathological. A systolic pressure of 100, in any adult, is also pathological.

Fear, pain and worry generally increase the systolic pressure but have little effect upon the diastolic. The systolic is lowered by undisturbed sleep of a few hours. Rest in bed for 24 hours or more will reduce an abnormally high pressure.

Physiology—The systolic pressure is equal to the diastolic plus the pulse pressure and represents the force of the heart to drive the blood through the arteries. The diastolic pressure represents the tension which the arterial walls exert upon the blood; it is the pressure that the left ventricle must overcome before the aortic valve opens. The systolic and pulse pressures show heart values and the diastolic pressure shows the end resistance.

In considering blood-pressure in a young adult where the systolic pressure is found above 120, ranging between that and 140, it will generally be found that he has an intake of too much food (probably meats, but might be fluids), and not exerting himself sufficiently to use up the added fuel to his furnace; his grates become clogged with clinkers, his blood by indican, etc., etc. This condition is known as hyperpiesia and will in time become serious. Therefore, it is important to regulate his pressure and teach him how to maintain it.

Hypertension means a sustained blood-pressure above normal and hypotension means a constant pressure below normal. Hypertension does not always depend upon the work of the heart, as it has often been noted that in cases of weakness of the heart muscle the pressure may be high, due to overfilling of the blood-vessels.

PULSE PRESSURE.

Pulse pressure, taken by itself, represents the force applied to the arteries by the heart during systole: That is, the heart's energy which produces a distension of the arteries, recognized as the pulse. The pulse pressure represents the heart load or overload and is of great importance in prognosis.

The pulse pressure should be 50 per cent. of the diastolic, and an increase of 40 mm. in load would indicate that danger is lurking near and that a sudden exertion might prove disastrous. For example: If the systolic pressure is found to be 210 and the diastolic pressure 110, the pulse pressure would be 100 minus 55, the normal limit, or 45 mm. overload. The greater the overload the greater the danger. On the other hand, should the pulse pressure suddenly fall 15 or 20 mm. trouble has already occurred. An operation upon a patient with 40 mm. excess heart load is dangerous in the extreme.

In myocardial degeneration with or without arrhythmia there may be high blood-pressure, but sooner or later the pressure falls. In such cases, if the pulse pressure be much over 50 per cent. of the diastolic, look out for heart failure. In myocardial disease mild exercise will be followed by a fall in the systolic pressure. If the heart be competent there will be a slight rise in pressure.

The Abrams method of testing for myocardial sufficiency is as follows: After taking the blood-pressure place over the heart region a pleximeter and strike the latter a series of vigorous blows with a plexor, after which immediately take the pressure again. If the myocardium is sufficient the blood-pressure remains the same or rises; otherwise it falls, and the rise and fall are in proportion respectively to the vigor and inefficiency of the heart mus-

cle. The test which I usually employ for myocardial weakness is: After taking the blood-pressure with the patient seated take it again in the standing position. If the pressure in the latter position is the same or higher the myocardium is sufficient; if lower, the myocardium is inefficient. In cases of nerve exhaustion the pressure may be lower in the standing than in the sitting position, but this condition is usually apparent. Blood-pressure may be high in cases with weak heart due to the action of the vasoconstrictors in an effort to compensate for the cardiac inefficiency.

Blood-pressure may be reduced through excitation of the depressor fibers by concussion of the spinous processes of the 2d and 3d dorsal vertebræ. The same results may be achieved by application of the slow sinusoidal current. Many times an interrupted weak faradic current will excite depressor fibers sufficiently to cause a fall in blood-pressure.

Blood-pressure may be raised through excitation of the pressor fibers by concussion of the 6th and 7th dorsal vertebræ or by application of the slow sinusoidal current. Cold water may cause sufficient peripheral excitation to increase the force of the heart contraction and cause an increase of blood-pressure.

Another method of raising blood-pressure is: Apply a metal electrode to the epigastrium with a vacuum electrode over the 3d to the 7th dorsal vertebræ, emitting a succession of sparks within toleration of the patient. Ice over the heart will increase blood-pressure and diathermy will reduce it.

In organic affections of the heart the pulse pressure may be normal, but should it suddenly increase it would indicate decompensation. Normally the pulse rate is eight or ten beats faster in a standing than in a recumbent

position. In cases of failing heart the rate may be as fast in the recumbent as in the standing position. We find in aortic incompetency a high systolic and a low diastolic pressure, hence a high pulse pressure. In mitral stenosis the blood-pressure is low on account of small amount of blood passing from the auricle to the ventricle. It is possible, however, to find normal pressures in valvular diseases of the heart.

Whenever digitalis seems to be indicated the sinusoidal current, with one electrode over the cervical and the other over the sacral vertebræ, will be of service.

In any heart trouble an efficient food tube is of prime importance. In myocardial weakness diathermy is of signal benefit.

To dithermatize a heart, place one electrode over the heart, the other directly opposite on the back and employ from 500 to 1000 milliamperes for ten to fifteen minutes.

BLOOD-PRESSURE IN SURGERY.

The importance of taking blood-pressure before, during and after surgical operations is becoming recognized more and more as our knowledge advances in cardiovascular values. All pressures should be noted before an anesthetic is administered and several times during the operation. Any sudden change gives the anesthetist warning before any other objective signs present themselves and gives him time to prevent untoward results. Any sudden drop in systolic pressure during or after operation is a danger signal which calls for stimulation at once. In taking the pressures at intervals during the operation you are advised just when the effects of shock begin. Any competent nurse is able to look after this

important matter without interfering with the work of the anesthetist or surgeon.

The normal variations in pressure during an operation should be understood as follows:

Irritation of nerve trunks—a rise.

Any cutting of tissue—a rise.

Opening the belly—a rise followed by a fall.

Manipulation of viscera—a rise followed by rapid fall.

When rapid reduction of pressure is followed by a gradual rise proper reaction is manifest, but when the fall continues from 90, 80, 70, 60 we know that shock must be combatted.

In surgical operations, if the pulse pressure falls below 20, look out for disaster. Ether usually produces a rise in pressure but chloroform causes a momentary rise, after which during the administration the pressure keeps falling. A mixture of nitrous oxid and oxygen gas has but little effect upon blood-pressure.

BLOOD-PRESSURE IN TYPHOID.

Uncomplicated typhoid is accompanied with low pressure, usually 90 to 100 systolic. As disease progresses the systolic pressure gradually falls and diastolic generally rises with consequent lowering of pulse pressure. About the fourth week a gradual rise in systolic pressure indicates recovery. A sudden fall in systolic pressure during course of disease points to perforation. After perforation occurs there is usually a rapid rise in pressure. The blood-pressure chart in typhoid is a safe guide in prognosis and of inestimable value in treatment.

BLOOD-PRESSURE IN TUBERCULOSIS.

There are some blood-pressure points worthy of note in relation to tuberculosis. It is well known that a con-

dition of hypotension prevails in advanced cases, and as the case becomes farther advanced there is a gradual reduction in the pulse pressure. Hypotension is often observed before any clinical signs are manifest. This is especially true if no other cause of impaired health is found. Hypotension is always present in the so-called pretubercular stage. Tuberculosis is often suspected, but if hypotension is not present we may be almost certain that our suspicions are groundless.

A reversal of pressures without clinical signs of other disease points to tuberculosis. Early pleurisy with effusion is sometimes difficult to diagnose from tuberculosis. If blood-pressure is normal or above, it points to pleurisy; if hypotension is present it points to tuberculosis. Hypotension always puts us on our guard, and in absence of infectious and wasting disease points to tuberculosis without other clinical evidence of the disease.

It is possible in cases of nephritis combined with tuberculosis that the effects of the nephritis on the vasomotor mechanism may offset the hypotension of tuberculosis, but a case of nephritis with low blood-pressure points to a tubercular kidney. A gradual rise in the systolic pressure in a case of tuberculosis points to an arrest of the disease.

BLOOD-PRESSURE IN PNEUMONIA.

Gibson's rule in pneumonia is a safe one to follow: When the arterial pressure expressed in mm. of mercury does not fall below the pulse rate expressed in beats per minute, the fact may be taken as an excellent augury, while the converse is equally true, *i.e.*, when the pulse rate per minute is higher than the pressure of the millimeters of mercury the equilibrium of the circulation is seriously disturbed.

NEURASTHENIA.

The systolic pressure in neurasthenia will be found to be low with a comparatively high diastolic and a consequent low pulse pressure. I have seen cases of neurasthenia with a pulse pressure of but 10 mm. due to marked nervous exhaustion on slight exertion.

MENOPAUSE.

Hypertension is frequent at the time of the menopause. Marked relief of hot flashes and nervousness may be obtained from auto-condensation.

OBSTETRICS.

A rise in blood-pressure in a pregnant woman will often be noted a month before albumen appears in the urine. If the systolic reaches 145 or over look out for eclampsia. If the pressure remains high, with no improvement in quantity of urine, premature labor is in order. Take the pressures as early as possible in your obstetric cases and as often as two weeks after the fifth month. One of the earliest and most constant signs of a toxic condition is a gradual increase in the systolic pressure.

It would be interesting and even profitable to go into the effects of all diseases affecting blood-pressure, but as these can be gleaned from your library mention is made only of such cases as are amenable to high-frequency currents.

HYPOTENSION.

However, we cannot pass by that condition known as hypotension—the opposite of hypertension and of equal importance. A hypotension always means lowered vitality, and its causes are more difficult of removal than

those of hypertension. A low systolic is often found with a high diastolic, hence a low pulse pressure which indicates an impaired heart. A systolic pressure in adults below 110 is considered hypotension.

Dr. E. H. Goodman classifies the causes of hypotension as follows: (1) Acute infections, excepting epidemic and cerebrospinal meningitis. (2) Chronic wasting diseases such as carcinoma, tuberculosis and cachexias (Addison's disease). (3) Hemorrhage and drugs. (4) Nervous diseases, special paralysis of the insane, neurasthenia after epileptic seizures, sometimes in tabetic crises after lumbar puncture, Graves' disease at times, osteoarthritis, exhaustion and shock, surgical or anaphylactic. (5) Cardiovascular diseases, tachycardia, dilatation of the heart, arteriosclerosis at times, mitral stenosis and decompensatory cardiac lesions. (6) Blood dyscrasias, anemia and polycythemia with splenomegaly. (7) Renal conditions, cyclic albumenuria, nephritis at times and amyloid disease. (8) Intoxications, alcohol, tobacco and adrenal insufficiency. (9) Terminal hypotension preceding death.

These cases tax the physician's skill to the utmost, but his work will be rendered much easier if he understands the effects of the different electric modalities.

METABOLISM.

Disturbances of metabolism are almost always found to be the leading factors in disease. It is, therefore, evident that permanent curative results cannot be obtained without a correction of the metabolic disorder.

Most drugs are very active in disturbing metabolic functions. Massage promotes bodily well-being but has no effect whatever upon metabolism. Cold water in liberal quantities increases metabolic changes. Heat, cold,

light and mechanical vibration modify metabolism. Muscular exercise has a profound effect.

Electricity influences metabolism in three distinct ways, says Dr. Kellogg: "First, by inducing chemical changes in the fluids of the body and stimulating cell activity; second, by raising or lowering the temperature of the tissues, thus bringing into action one of the most powerful of vital stimulants; third, by invoking muscular contraction and thus irritating the series of remarkable metabolic activities which are associated with muscular movement.

"Muscular movements may be induced by galvanic, faradic or static currents, but the sinusoidal will be found to be the most convenient and effective. The influence of electricity in increasing metabolism is not transient stimulation during a séance but definite and permanent change in the rate of activity."

While I do not desire to cause you fatigue or that you should think I may be taking too much time for the consideration of cardiac and renal diseases, at the same time I do feel that they are the principal diseases which you, as dispensors of high-frequency currents, will be called upon to treat; that a little time spent will not prove irksome, but, on the other hand, may be of some assistance in your work.

It has long been a puzzling problem to pathologists to determine the onset and initial stages of certain types of combined vascular and renal disease and to determine whether the myocardial disease were the primary and the renal disease the secondary, or the renal condition primary and the condition of the heart secondary. It is also somewhat of a problem how to treat the dyspnea, stupor, pulmonary edema or general failure of health symptoms, all common to cardio-renal disease.

It will be safe first to treat the patient with auto-condensation, then individualize him and make such changes in diet as seem best under the circumstances.

If by treatment by auto-condensation the systolic pressure is reduced and you get but little or no effect upon the diastolic, the primary cause will be found to be renal. The ordinary functional renal tests will be found valuable in this connection.

The color test will be found nearer the normal in primary cardiac cases than in primary renal cases. The blood urea will be found to be much higher and the urinary nitrogen much less in primary renal cases. The urine in primary cardiac cases will be found to be less in quantity and of higher color and higher specific gravity than normal. A careful ophthalmoscopic examination will be of considerable help.

Primary cardiac cases are more amenable to the action of digitalis. In primary renal cases the caffein group of remedies will yield better results than digitalis. This is mentioned as a point in diagnosis. A person with advanced heart disease has an idiosyncrasy toward many proteins, and a thoughtful physician will endeavor to ascertain what they are and remove them from the diet. Animals fare very well on one protein for a lifetime. Man can get along very well on one and has been known to improve by it.

Some people have a poor vascular system from birth and are destined to have heart disease in middle life. The arteries of men are not so unlike the hose sold by your hardware merchant: He has several grades; some will last one season, others will last two seasons while one grade will probably last for years.

When you have a young patient with a weak grade of blood-vessels, commence at once on his diet, his work and play, that his life may be prolonged and useful.

CHAPTER VII.

HYPERPIESIA.

Essential features distinguishing hyperpiesia from hypertension of nephritis and arteriosclerosis. Early manifestations and treatment. Effects of altitude. Clinical reports. Blood-pressure charts.

HYPERPIESIA is a word coined by Dr. Clifford Allbut, professor of Physic in the University of Cambridge, England, descriptive of cases of hypertension without arteriosclerosis, nephritis or marked cardiovascular disturbance.

Since the sphygmomanometer has come into general use it has been the custom of physicians to classify all hypertensive cases as Bright's disease or arteriosclerosis. Hyperpiesia, the condition to which your attention is called, belongs to neither of the classes mentioned. It is a condition that might be called the stage of precardio-renal disease, because of its existence probably for years before physical or laboratory examinations can detect abnormal conditions of the heart or kidney. If a person has even minor apoplectic attacks he is considered a case of arteriosclerosis; and he may be, but it does not necessarily follow that it is the causative factor.

We have all seen cases where no sclerotic condition of the arteries could be found, nor would the urinary findings justify us in making a diagnosis of Bright's. Dr. Janeway has applied the term "chronic hypertensive cardiovascular disease" to this class of cases. This condition has been noted by many prominent clinicians who do extensive work along these lines, but it was left to Allbut to give us the happy-thought-name of hyperpiesia for this condition.

THE KIDNEY

The kidney is a small organ, but it is the most important in the body. It is the organ of excretion, and it is the organ of the blood.

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I believe that the general idea among physicians concerning blood pressure is about as follows: That the blood vessels are not so much affected directly as indirectly through the kidneys which are damaged and unable to do their work properly, hence the heart becomes hypertrophied in order to force the blood through the kidneys and increased blood pressure or hypertension is the result of this increased power of the heart and that the phenomenon is one of compensation.

Nothing could be much farther from the truth. Cardiac hypertrophy does not *per se* cause increased blood-pressure, neither does impeding the circulation through the kidney cause hypertension.

Increased blood-pressure is a premonitory indication of pathological changes yet to come, and is not, as has been supposed, the result of arterial changes. In other words, the cause of persistent hypertension is now considered to be the primary cause of the structural changes in the arteries and kidneys.

The cause of hypertension lies in the increase of protein decomposition and the absorption of amino acids, as well as the individual sensitiveness (idiosyncrasies) to certain articles of diet. At any rate the cause is to be summed up at once in deranged metabolism.

The prevailing notion in the minds of many that hypertension is compensatory, and that the blood-pressure should *not* be lowered, is entirely disproved by the experience of many observers.

Persistent hypertension naturally causes cardiac hypertrophy which develops to overcome the resistance; This is a physiological and not a pathological process. When you find a case of hyperpiesia you know that sooner or later hypertrophy will follow unless the cause is removed. Heart-murmurs are the ear-marks of previous hyperpiesia.

EFFECTS OF ALTITUDE.

The effect of altitude upon blood-pressure is one of oxygen hunger. In this respect there are the widest individual variations from the man who cannot withstand the least want of oxygen to the one who can go to an altitude of 20,000 feet with no ill effects. The strain upon the circulatory apparatus imposed by altitude is very similar to that induced by extreme exercise. The effects

of altitude vary greatly according to man's physical condition at the time of making the ascent. A slight cold or an attack of indigestion, or any other condition lowering his resistance affects blood-pressure to a certain extent at sea level, and it is quite evident that such a person will experience an uncomfortable feeling at even a moderate elevation of 5000 feet.

An increased rate of blood flow has been demonstrated in men living at high altitudes. Dr. Edward C. Schneider, of Colorado Springs, has made extended observations on Pikes Peak (14,110 feet) which indicate that the increase in the rate of flow is largely the result of a greater frequency of heart beat. When the heart begins to accelerate, the diastolic pressure usually begins to fall and the systolic begins to rise; later on there may be a fall of both due to the overcoming of the vasomotor mechanism by oxygen want. In an ordinarily healthy individual there is little or no effect upon the blood-pressure until an altitude of 8000 feet is reached. There is practically no difference in blood-pressure in a norm from sea level to an elevation of 7000 feet. Individuals with high pressures who have arterial changes in the form of sclerosis and those with a poor vasomotor control do badly in high altitudes (above 8000 feet).

There is no condition which should be more frequently investigated by the physician than the arterial tension. He will be warned earlier of the presence of toxic matter in the blood by taking the blood-pressure than by any other method. Even at this late day blood-pressure work is by some pseudoscientific men termed a fad.

The sphygmomanometer, like all other implements of the profession, has been grossly abused and its readings used to magnify a patient's troubles by men who have not, and probably never will have knowledge of

its proper use. It has been used by quacks for the sole purpose of transferring cash from their victim's pocket to their own. Its use, like electricity, has been condemned by men who should know better, but happily the number of these false prophets is growing less.

We often see in medical journals and in some books such statements as "the physician should not meddle with nature's methods until such time that she fails." Who is to be the judge of nature's methods so as to be able to decide when or where she fails? It is possible that nature is trying to tell us by the signal of hypertension that a storm is approaching and to advise us to put our house in order. We often hear that blood-pressure is a provision of nature and is always compensatory; also, that a contracted kidney impedes the circulation, and that, in order to overcome the resistance and be able to do its work the heart hypertrophies, and this increase in the heart's energy causes hypertension.

The argument that hypertension is nature's defense will not hold good, as this condition antedates by months and even years the kidney lesion and consequent hypertrophy of the heart.

Toxemias develop and the poison irritates the adrenal and cardiovascular mechanism as well as the heart muscle itself. Does hypertrophy tend to relieve this condition? No, because these poisons are the direct cause of the hypertension.

When a fire is built within the body to keep off the foe, man calls it fever and along comes the doctor with a bucket of acetanilid and puts out the fire. Nature's methods misunderstood!

There are cases of myocardial inefficiency, clinically shown by dyspnea, cyanosis and edema, with no hyper- or hypo-tension. Again is nature misunderstood.

Venous stasis of the liver or altered viscosity of the blood may occur and result in hypertension and no lesion of the heart be demonstrable. A family row may cause hypertension; does nature raise the blood-pressure to stop the row?

The systolic pressure represents the energy of the heart during systole, the diastolic the energy factor in overcoming end resistance. I prefer the term *end resistance* because it is not always at the periphery.

I believe we should know the amount of energy spent by the circulatory system in a minute or an hour. We need this information especially in cases in which we fear a giving-way of the vessels, such as apoplexy and other hemorrhages.

Barach has called the method of obtaining this information the "energy index." He states: "From the pulse rate we know how many systoles and how many diastoles to each minute there are in the arterial tree." For example, if the maximum pressure is 120 mm. the minimum pressure 70 mm. and the pulse rate 72 per minute, the exertion in one minute would be:

In systole	120 × 72 or	8,640 mm. of Hg.
In diastole	70 × 72 or	5,040 mm. of Hg.
In both	190 × 72 or	13,650 mm. of Hg.

which represents the total effort exerted by the circulatory system in one minute.

The advantage of this method will appeal to you, for it is not always true that a high systolic pressure is accompanied by a high diastolic.

I have seen it mentioned many times that the pulse rate is of no significance in taking blood-pressure. This seems very unfortunate for the reasons heretofore given. It is true that the pulse rate may be very slow and the

blood-pressure high, or, the rate may be rapid and blood-pressure high, or *vice versa*. It is not a factor in producing hypertension, but the wear and tear upon the vessels by numerous systoles and diastoles are at once apparent. To illustrate, take three cases in apparent health, whose systolic, diastolic and pulse pressures are within the limits of normal, as follows:

	Systolic	Diastolic	PR	PP	Energy Index.
Case 1.	120 +	70 ×	70	50	13,300 mm. of Hg.
Case 2.	130 +	104 ×	84	26	19,656 mm. of Hg.
Case 3.	135 +	105 ×	85	30	20,600 mm. of Hg.

It has been shown by repeated experiments upon hundreds of cases that a maximum energy index consistent with safety to the vascular system is between 19,000 and 21,000 mm. of Hg. We have been taught that a pulse pressure between 26 and 56 is within normal limits.

Let us analyze these cases without taking into consideration the energy index:

No. 1.	Systolic P.	120	Diastolic	70	Pulse P.	50	normal.
No. 2.	"	130	"	104	"	26	"
No. 3.	"	135	"	105	"	30	"

These pressures as well as the pulse rate are within normal limits. Without consideration of the energy index we would be led to believe by all records of the sphygmomanometer that the circulatory systems of these cases called for no particular attention upon our part, but by a careful analysis with the energy index we find case No. 1 perfectly safe, No. 2 at safety limit and No. 3 entering the danger zone. Nos. 2 and 3 call for treatment.

Let us consider persons of another class, who are often heard to remark: "Never felt better in my life."

	S.	D.	PP	PR	Energy Index.
No. 1.	170	115	55	80	22,800
No. 2.	170	120	50	80	23,300
No. 3.	160	120	40	84	23,520

Upon a thorough physical and laboratory examination of all these cases there are no discoverable lesions.

Upon careful analysis we find No. 1 with a systolic pressure of 170, a little high; diastolic of 115, a little high, the pulse pressure of 55 considered normal, pulse rate of 80 considered normal, hence nothing to worry us; but when we go a little farther we find an energy index of 22,000, and, knowing that the vascular system is carrying a load at or beyond safety, we institute treatment by auto-condensation and save him from disaster.

No. 2, systolic pressure (170) a little high; diastolic (120) a little high, but pulse pressure only 50 and pulse rate 80, with no physical or laboratory signs; we may let him go with a little advice about intake of proteins and not to overexert himself, but when we look at the energy index which is 23,300 we feel that something should be done.

No. 3 is 60 years old and his systolic pressure only 160. No significance, we say. With his diastolic 120, a little high, his pulse pressure is but 40 (absolutely normal), and his pulse rate 84, also perfectly normal, so, why worry? However, we further find his energy index 23,520, the highest load of any of the three cases. Let us then commence a vigorous treatment with auto-condensation and add ten years to this man's life.

The blood of man completes its circuit of the body about $2\frac{1}{2}$ times a minute. The force expended upon the circulatory system in twenty-four hours is sufficient to raise the body of an ordinary man $\frac{2}{3}$ of a mile into the air. If by a strenuous life, excessive intake of food and

possibly alcohol he increases his energy index 50 per cent., it is not difficult to understand that his life will be materially shortened.

TREATMENT.

The ideal treatment for hyperpiesia is found in high-frequency currents by the auto-condensation method. The patient should be treated daily until the systolic pressure reaches the same point with each treatment. This will be the point of compensation for that individual. This is the point known as *fixed tension* or point of compensation, and it will be impossible further to reduce the pressure. Auto-condensation cannot impair cardiac sufficiency. When the point of fixed tension is found the frequency of treatments is so regulated that this point may be maintained.

There are a few "don'ts" in connection with auto-condensation treatments:

Don't employ auto-condensation in cases of low systolic and high diastolic pressure.

Don't employ over 300 milliamperes in old cases of arteriosclerosis until you are assured that your patient will withstand more to his advantage. Always watch your patient and when the veins of the wrist begin to dilate or the patient begins to perspire stop the treatment for that time. You will soon learn the milliamperage best suited to each patient. The range is between 300 and 700 milliamperes.

Don't suddenly increase the dose. Start with 300 milliamperes and gradually increase the milliamperage by opening the spark gap rather than increase the voltage. The best results are obtained by low voltage. The spark-gap increases the amperage without increasing the voltage. The rheostat set on the first button will be

found sufficient in robust subjects, but in the attenuated you may have to use the entire spark-gap and the second or third button of the rheostat.

The causes of hyperpiesia must never be lost sight of; endeavor to find the particular article of diet that has produced this condition and eliminate it. Do not lose sight of the fact that the cause will be found in deranged metabolism and will have to be ascertained in each individual case.

My method of finding the causative factor is: Eliminate all proteins from the diet for a period of one week, then allow one protein a day for three days; if no disturbance of blood-pressure occurs add another for a period of three days, and so on until the offending one is found, then eliminate it from the patient's diet forever.

I have had cases of hyperpiesia that reported once in three months, and found treatments unnecessary for periods as long as one year. If the hyperpiesia has continued long enough to produce pathological results, it is patent that the period of observation is very much shortened and may require weekly observations.

The blood-pressure in hyperpiesia can always be reduced to normal and be maintained if it has not exceeded 170 systolic.

In advanced cases of arteriosclerosis with a systolic pressure above 200, much may be done to ward off a cerebral accident.

In cases of nephritis with hypertension, while the pressure may be lowered it cannot be maintained without increased elimination by the kidneys.

To show that some physicians, outside of those who make a specialty of electrotherapeutic methods, are seeing the light, I desire to quote Prof. Allbut in Musser's last edition (1917) of Practical Treatment. He says: "I

may say, however, that in my farther experience of the high-frequency current in cases of high blood-pressure, I have reason to speak with increasing confidence of its beneficial effects."

EFFECTS OF AUTO-CONDENSATION.

The curing of hyperpiesia by auto-condensation, and its beneficial results in all cases of hypertension, may be stated to be due to an increase of tissue changes by increasing oxidation; elimination of waste products in the urine, due to a more complete oxidation of nitrogenous matter in the body; its special effects upon the protoplasm of tissue cells; its elimination of carbon dioxid and its rapid elimination of toxins; its increasing oxygen carrying power of the blood as well as causing the increase of hemoglobin. These effects are due to an action upon the sympathetic nerves controlling vasomotor, secretory and peristaltic functions.

An enlarged heart, whether it be from hypertrophy or dilatation, is reduced by auto-condensation.

There is a decrease in weight on account of increased oxidation. This is noticeable in cases of obesity.

There is an increase of bodily temperature from $\frac{1}{2}^{\circ}$ to 1° F. due probably to its profound effects upon the vasomotor system. It is necessary to administer laxatives during these treatments to avoid effects of increased metabolism.

If a kidney is so contracted that it cannot perform its function there is no treatment that will be of so much service as the high-frequency current by diathermy.

Allow me to urge the importance of periodic examinations of the blood-pressure of supposed healthy individuals in middle life to detect and correct existing faulty conditions. The supreme duty of a clinician should be

to teach his patients how to live, how to correct and control their appetites and live in a way that will prevent the otherwise certain cardio-renal disease.

The following cases are chosen from my records to illustrate the effects of auto-condensation upon hypertension from different causes:—

CASE No. 620.—Mr. H., a dealer in livestock, age 60, native of U. S. Father died of apoplexy at the age of 72; mother died of tuberculosis at the age of 45; one brother died of paralysis at 55; two brothers died in infancy. Past history: Always been well, has drank some alcohol but not considered a boozier; uses tobacco freely; a heavy consumer of proteids. Present condition: Complains of fulness in the head but it does not interfere with work or sleep. Pulse 100, full and regular; weight, 212; blood-pressures—systolic 186, diastolic 118. Urine: Acid in reaction; specific gravity, 1020, no albumin, no casts; nitrogen output normal, chlorids normal. Prostate slightly enlarged but causes no discomfort. Cardiac area of dulness increased downward and to the left 2 centimeters. No heart bruits. Mild exercise increases pulse rate to 120 but becomes normal in three minutes. Diagnosis: Hypertensia. Treatment: Auto-condensation and limited supply of proteids. One year later pulse 80, blood-pressure—systolic 150 and diastolic 100. See Chart No. 620.

CASE No. 535.—Mr. P., aged 65, clerk in a book-store; native of U. S. Family long lived, except one brother who died of tuberculosis. History: Never had an infectious disease; always able to work; had spells of dyspnea at infrequent intervals during the fall of 1915, made worse by exertion. Habits: An occasional drink of whiskey all his life; used tobacco for many years but none during the past five years; not a heavy consumer of proteids but had frequent attacks of indigestion; habitually constipated. Examination: Pulse 50 (his pulse has always been below 60); blood-pressures—systolic 190, diastolic 120 (Jan. 3, 1916); area of cardiac dulness

1 inch to left of nipple also downward; no bruits; systolic pressure 6 mm. lower on standing than sitting and highest in horizontal position. Urine: Quantity 40 ounces, clear and amber in color; specific gravity 1030; albumen $\frac{1}{2}$ Gm., solids 70 Gm., no casts. Diagnosis: Cardio-renal disease, cardiac dilatation with myocardial insufficiency. Would not take proper treatment. See Chart 535. General anasarca supervened and he died in October, 1918.

CASE No. 555.—Mr. K., aged 74, a retired farmer, native of Ireland. Family history: Paternal, maternal and collateral all good. Several years ago he had a severe illness following an injury to the hip-joint. Has been constipated for years requiring enormous doses of physic. Complains of pains in hip and legs. Hip-joint partially ankylosed. Never used alcohol nor tobacco. Has consumed a fair amount of proteins all his life. Area of cardiac dulness normal; no bruits. Radial artery hard and tortuous. Suffers from cold feet and crampy muscles. Urine: Quantity 50 ounces, clear and acid in reaction; specific gravity 1022. No albumen nor casts. Small amount of indican present. Diagnosis: Arteriosclerosis. Treatment: Auto-condensation. See Chart 555.

CASE No. 575.—Mrs. H., housewife, aged 58, native of U. S. Family history good. Personal history: In 1893 she had puerperal convulsions but made a good recovery with no damage to kidneys. Five years later she became a Christian Scientist and has enjoyed good health until three months ago when she began to be troubled with insomnia and pain in the occipital region, slight vertigo and paresthesia in left arm, which prayer would not remove. Examination: Pulse 84, temperature 98, blood-pressures—systolic 250, diastolic 120; dilatation of pupil of left eye; reflexes exaggerated; constipated. Urine: Quantity 40 ounces, acid in reaction, specific gravity 1018; no albumen, no casts. Area of cardiac dulness normal. No bruits. Diagnosis: Hyperpiesia. Treatment: Auto-condensation. No change in diet. See Chart No. 575.

Her blood-pressure remains under 150 systolic without treatment (now over two years).

CASE No. 623.—Mrs. S., housewife aged 50, native of Arkansas. Family history of no bearing. Personal history: Had always been well until June, 1918, when she had a slight stroke of paralysis. Examination: Oct. 17, 1918. Diet for months upon arising had been hot water and sugar. Breakfast, canned salmon fried, hot biscuits and coffee. Lunch, fried salmon, fried potatoes, cabbage, cold biscuits, pie and coffee. Dinner, beans, fried salmon, hot biscuit and coffee. Pulse, 80, temperature 98, blood-pressures—systolic 216, diastolic 90. Cardiac dulness increased to left. No bruits. Urine: Quantity 50 ounces, cloudy and pale, reaction alkaline, specific gravity 1020; no albumen; no casts; indican present. Diagnosis: Hyperpiesia. Treatment: Borate of sodium and benzoic acid until urine gave an acid reaction. Diet: Coffee-free and limited amount of proteins. Auto-condensation for six days. See Chart No. 623.

CASE No. 601.—Mrs. T., housewife, age 50, native of U. S. Family history good. Personal history: Has had severe headaches for three years, the last two of which she has taken osteopathic treatment without benefit. Always a good feeder. Pulse 75, temperature 98. Blood-pressures—systolic 214, diastolic 80. Eyes suffused. Sleep disturbed. Spells of indigestion. Constipated. Heart: Slightly increased area of dulness, no bruits. Urine: Normal. Diagnosis: Hyperpiesia. Treatment: Auto-condensation. No change in diet after fourth treatment; systolic pressure 150, diastolic 80. Four days afterward she returned with a systolic pressure of 180. She reported having had a family row the previous evening. Two more treatments reduced the systolic pressure to 140 where it remained for 30 days when she left the state. See Chart No. 601.

CASE No. 610.—Mrs. B., age 61, occupation none, native of U. S. Family history: Nothing of importance to report.

Personal history: A housewife for many years, always worked hard. No illness of importance until June, 1918, when she suffered a stroke of paralysis. She had not, on Oct. 8, 1918, fully recovered use of muscles of right side. Pulse 90; regular, no heart bruits; area of cardiac dulness increased 2 centimeters to left. Complains of pain in right shoulder and arm. Eyes suffused, pupils react to light normally. Tongue coated. Sleep fair. Mentality somewhat impaired. Sphincters relaxed, has partial control of urination. Gait more or less staggering. Reflexes exaggerated on the right side. Urine: Quantity 48 ounces, reaction acid, specific gravity 1010. Albumen $2\frac{1}{2}$ Gms. Casts hyaline and granular present. Nitrogen output decreased. Blood-pressures—systolic 214, diastolic 120. Diagnosis: Cardio-renal disease. Treatment: Auto-condensation. Four treatments reduced systolic to 170 and diastolic to 110. Albumen reduced to $1\frac{3}{4}$ Gm. Better use of muscles. Diathermy of heart and kidneys advised, but she returned home to another state. It is needless to say that this case is incurable, but much could have been done by judicious applications of auto-condensation and diathermy in toning heart muscle and keeping up the elimination. Note reversed systolic showing heart weakness and high diastolic when standing, indicating kidney resistance. See Chart No. 610.

CASE No. 840.—Mr. W. W. W., age 45, a druggist. Family history: Paternal, maternal and collateral "husky." Personal history: Has been in the drug business for 24 years. Always well until one year ago when through financial difficulties he had what was called a nervous breakdown. Has been irritable and easily excited since his trouble one year ago. Has suffered more or less from hemorrhoids. Habits: Has drank more or less alcohol, but was never drunk. He is an inveterate smoker which he says "settles his nerves." He has sensations of impending danger. He was referred to me for treatment for high blood-pressure. Examination: Pulse 80; regular. Blood-pressure—systolic 170, diastolic 108 in

sitting posture. On standing his pressures were, systolic 162; diastolic 112. It will be noted that his systolic pressure is reversed, indicating cardiac weakness. No heart murmurs. Area of cardiac dulness normal. Urine: Specific gravity 1020, acid, no albumen, no sugar, no casts and no indican. Urea normal. Treatment: Auto-condensation 350 to 600 milliamperes for fifteen minutes daily. His fixed tension was found to be systolic 138, diastolic 108. On the 28th he had a fit of anger when his pressure went to 168 which promptly returned. Note that his standing pressure became normal during the excitement. His pressure has remained at about 140 for several months. See Chart No. 840.

CASE No. 845.—Mrs. J. P. T., age 41, occupation, housewife. Family history good. Personal history: Has borne several children. Has had frequent attacks of tonsillitis, tonsils removed. Has had an operation for repair of perineum. Six months ago had albumen in the urine. Has suffered for six months with a rectal fistula. She was referred to me for reduction of blood-pressure preparatory to an operation for the relief from the fistula. Examination: Pulse 96; regular. Blood-pressure—systolic 240, diastolic 138 in sitting posture. On standing the pressures were systolic 250, diastolic 150. Area of heart dulness extended 1 inch to left of nipple. Apex beat low and to the left. No murmurs. The cardiac hypertrophy accounts for the high pressure in the standing position. The high diastolic indicates great end resistance which is probably in the kidney. Urine: Specific gravity 1020, acid, no albumen, no sugar, small amount of indican. Urea decreased. Treatment: Auto-condensation 350 to 500 milliamperes for fifteen minutes daily. The pressure receded to 200 where it remained. Nothing is to be expected in a favorable way until the focus of infection is removed. See Chart No. 845.

CASE No. 852.—Mr. W. H. D., age 30, a shoe merchant. Family history of no bearing. Personal history: Always been well; was a foot-racer and mountain climber during his

college days. Habits: Always a moderate drinker and smoker and somewhat of a sport. Never felt otherwise than well. On making application for life insurance his blood-pressure was found to be too high. He was advised to return for another examination in six months. When the six months passed he came to me to see about his blood-pressure before taking the examination. Examination: Pulse 98 regular. Blood-pressure—systolic 168, diastolic 78. Standing pressure, systolic 176, diastolic 90. Area of cardiac dulness increased 1 inch to left. No murmurs. Urine: Specific gravity 1024, acid, no albumen, no sugar, no indican. Urea normal. Treatment: Auto-condensation. Four treatments reduced the pressure to normal where it has remained. See Chart and note standing pressure 10 points above sitting pressure indicating cardiac hypertrophy.

5 CASE No. 848.—Mrs. E. L., age 60, housewife. Family history not important. Personal history: Always been well. About one year ago she noticed that her thyroid was becoming enlarged. Little attention was paid to it until recently when she consulted a surgeon. He found her blood-pressure too high for operation and referred her to me. Examination: Pulse 86, full and regular. Blood-pressure—systolic 210, diastolic 100. Standing systolic 220, diastolic 110. Heart enlarged 1 inch to left and downward. Thyroid shows a well developed adenomatous goiter. Complains of vertigo. Urine: Normal. Treatment: Auto-condensation. When the systolic pressure reached 180 the vertigo disappeared. Her fixed tension was found to be between 170 and 180. See Chart and note the typical standing pressure in cardiac hypertrophy.

CASE No. 851.—Mrs. G. A. R., age 61, housewife on a farm. Family history of no bearing on the case. Personal history: Has borne six children. Was always well until eight months ago when she had all her teeth extracted on account of pyorrhea. Felt badly for four months when she had a slight stroke of paralysis of the right side. At that time she had albumen in the urine. She gradually recovered

from the paralysis and was referred to me for treatment for high blood-pressure. Examination: Pulse 80 and irregular. Blood-pressure—systolic 230, diastolic 120. Standing systolic 226, diastolic 138. Heart enlarged to the left and downward. A mitral murmur present. Urine: Specific gravity 1010, acid, no albumen, no sugar, no casts, small amount of indican, total solids 41 Gms. Has atonic constipation. Treatment: Auto-condensation with little or no effect except an increased elimination. After five treatments the urinary solids increased to 69 Gms. This case shows the effects of infection upon blood-pressure.

PLATE I.

CASE No. 620

BLOOD PRESSURE CHART

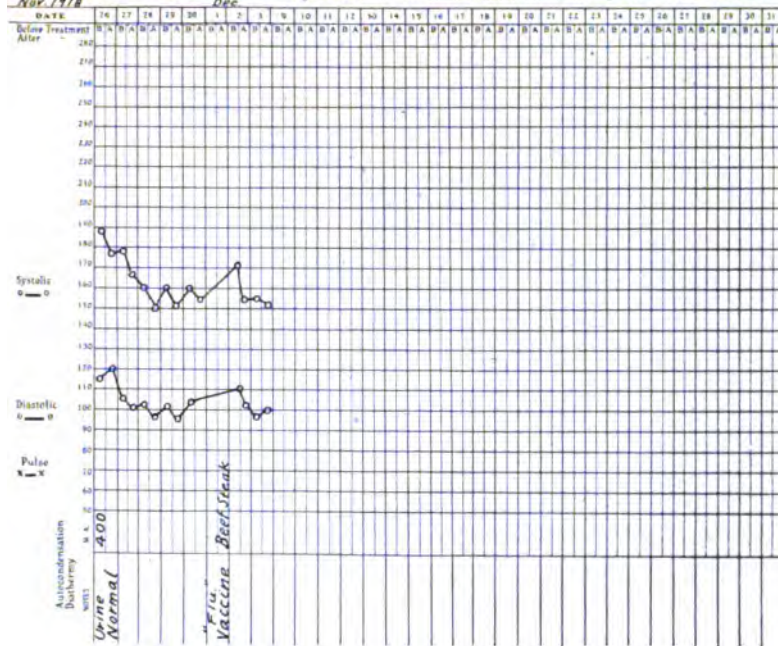
WARD NO.

Name Mr. C. H. H.
 Date Nov. 18, 1918

Age 60

B.B.G.

Diagnosis: Hyperpiesia



CASE No. 535

BLOOD PRESSURE CHART

WARD NO.

Name E. M. P.
Jan 1816

Age 65

Doctor *B.B.G.*

Diagnosis Cardio-renal

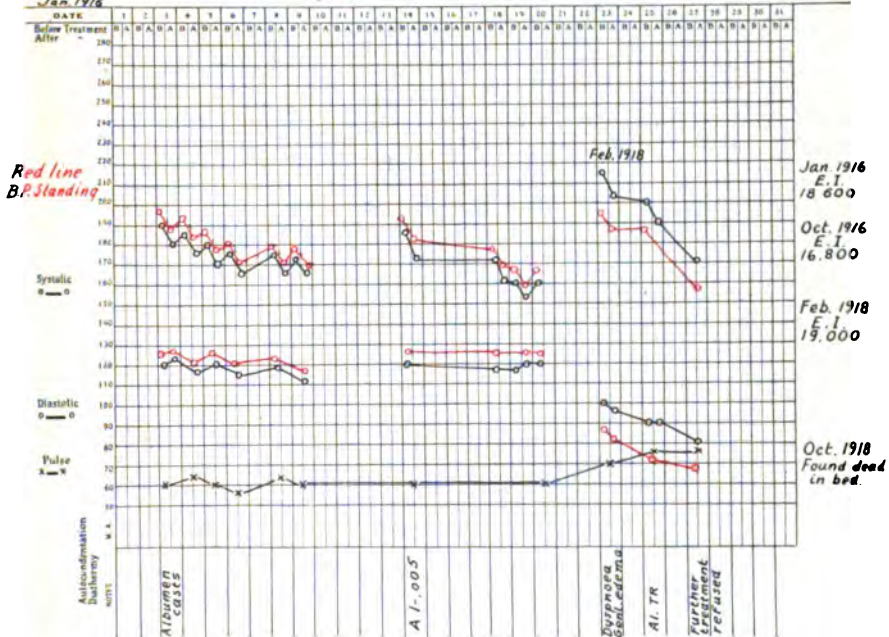


PLATE II.

CASE NO 555

BLOOD PRESSURE CHART.

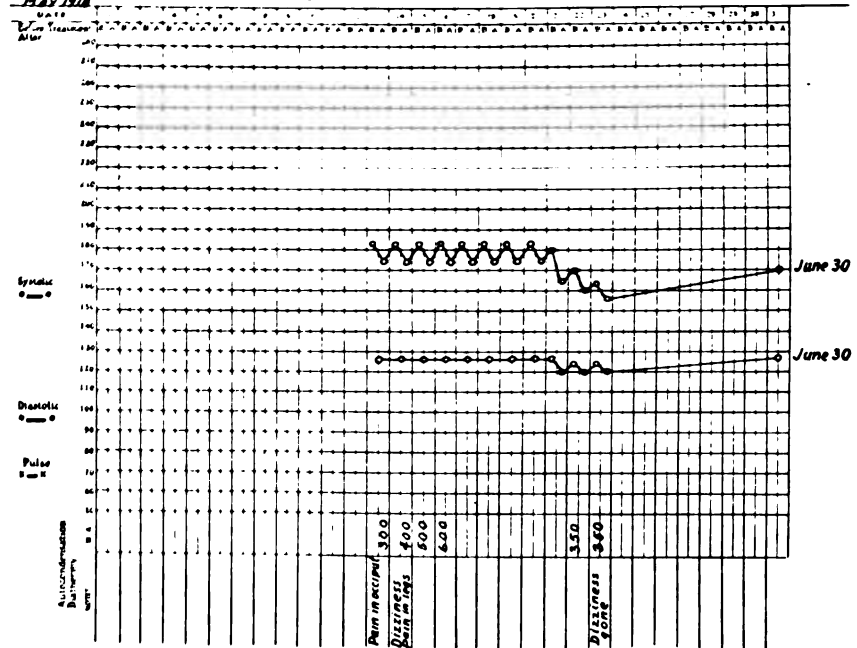
WARD NO.

Name Mr S K

Age 75

Doctor B. B. G.

Diagnosis Arterio-sclerosis



CASE No 575

BLOOD PRESSURE CHART

WARD NO.

Name Mrs. A. C. H.

Age 58

Doctor B. B. G.

Diagnosis Hypertension

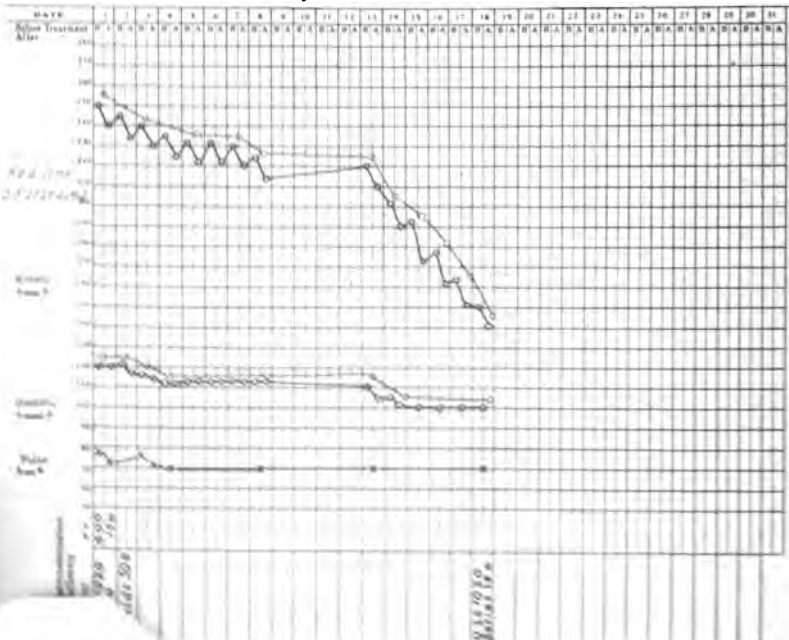


PLATE III.

CASE No. 623

BLOOD PRESSURE CHART

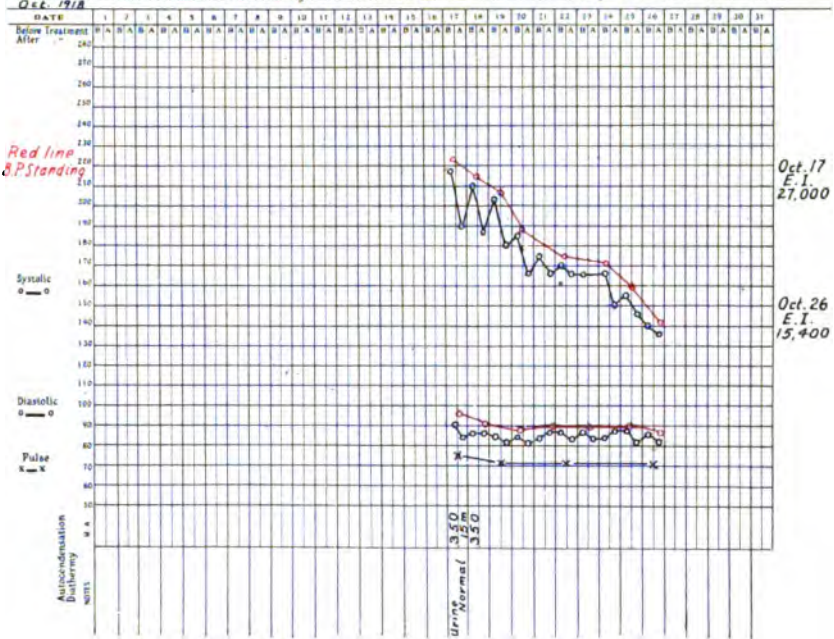
WARD No.

Name Mrs. J.M.S.

Age 50

Doctor B.B.G.

Diagnosis Hyperpiesia



CASE No. 601

BLOOD PRESSURE CHART

WARD No.

Name Mrs. E.E.T.

Age 50

Doctor B.B.G.

Diagnosis Hyperpiesia

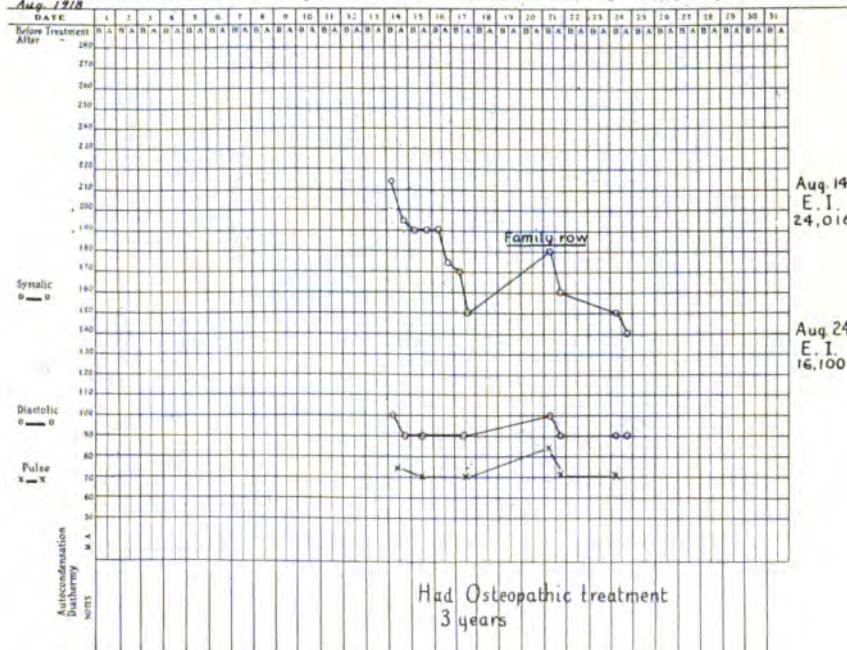


PLATE IV.

CASE No 610

BLOOD PRESSURE CHART

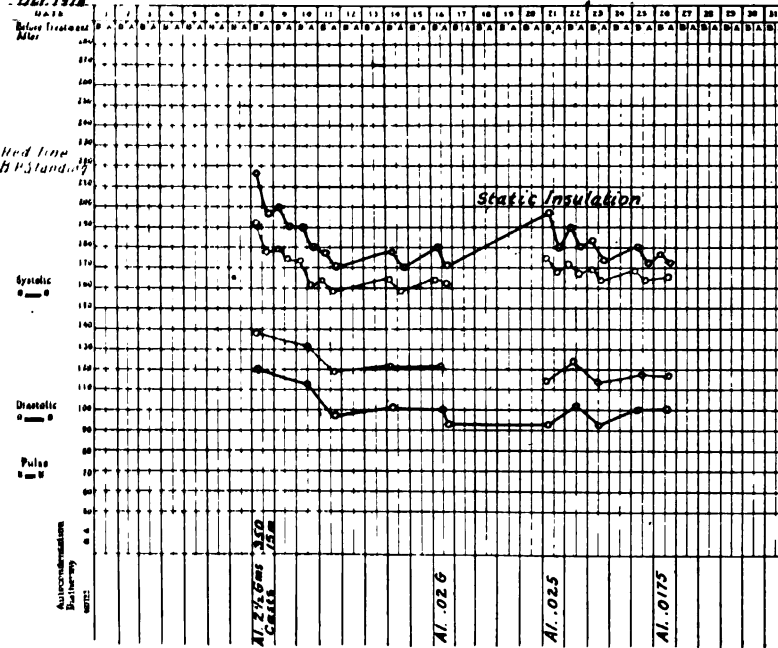
WARD No. _____

Name Mrs. B.

Age 61

Doctor P. B. G.

Diagnosis Nephritis



CASE No 840

BLOOD PRESSURE CHART

WARD No. _____

Name W. W. W.

Age 45

Doctor S.

Diagnosis Hypertension (arteriosclerosis)

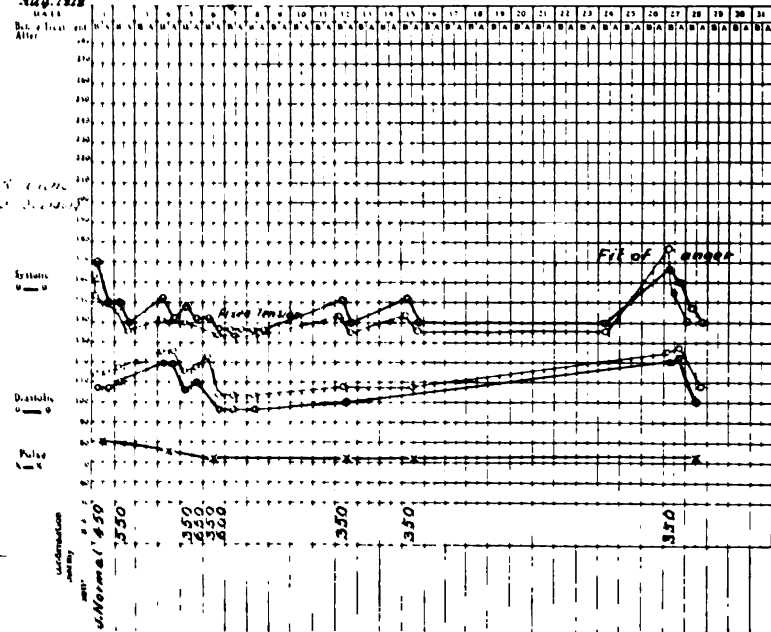


PLATE V.

CASE NO 845

NAME Mrs. J. P. T.
Sext. 1810

BLOOD PRESSURE CHART

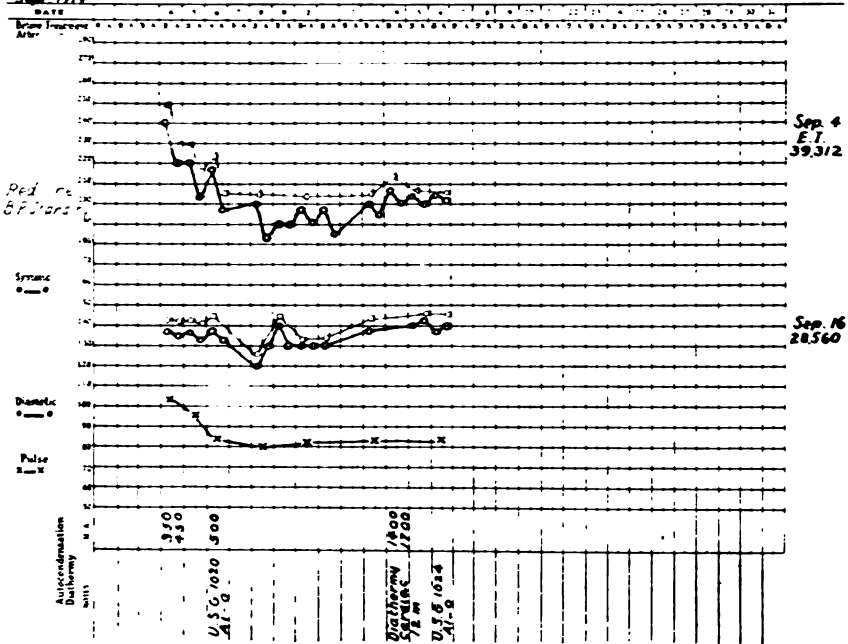
Age 41

Doc's S.

WARD NO.
116

Diagnose *Focal Infection*

Diagnose *Focal Infection*



CASE No 852

Name W. H. D.
Date 1918

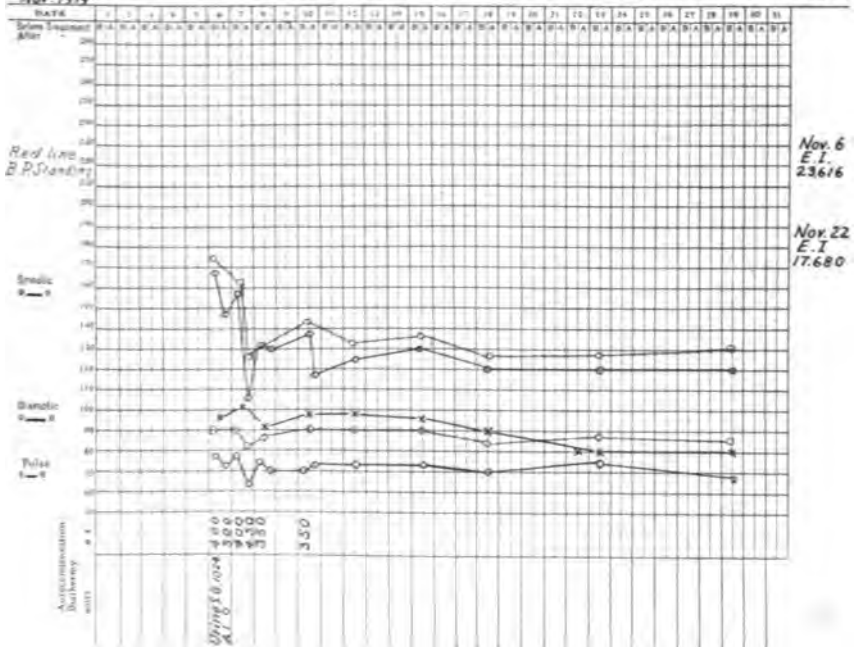
BLOOD PRESSURE CHART

Apr 30

Doctor **B.B.G.**

WARD NO.

Diagnosis **Cardiac Hypertrophy**



WARD NO.

WARD NO.

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CHAPTER VIII.

GENITOURINARY DISEASES.

Sexual instinct. Gonorrhea. A few don'ts. Gonorrheal prostatitis. Virghi's treatment. Roccayrol's treatment. Geyser's treatment. Gonococci and heat. Treatment of orchitis and epididymitis. Sexual impotence. Treatment of papilloma of the bladder. Treatment of diseases of the uterus.

SEXUAL INSTINCT.

CIVILIZATION is but the control of human instincts. The more of our instincts controlled the higher we are in civilization. Most of our instincts are suppressed in a greater or less degree, but those of greed, hunger, thirst and sex have scarcely been touched upon. A man will throw off the cloak of civilization for thirst and hunger; for greed he will remove his waistcoat, put on heavy armor and become a target for bullets; and he will strip to the skin and plunge through the brambles of poverty, shame and crime for sex. He will leave his happy home for the pouting ruby lips and rustling skirt.

Venereal disease causes more suffering and far-reaching disastrous consequences than any other known to our profession, and it is probably the most preventable, but before any material control can be had, man's sexual instinct must become partially civilized.

The great instinct of man, around which all others revolve, is sexual appetite, the satisfaction of which has destroyed kingdoms and empires. It has filled our asylums and hospitals with more maimed and dying than all the wars of history. And again, if it were possible to

suppress this instinct all kingdoms, empires and humanity itself would crumble into dust and return to the elements from whence they came.

From primitive times, when venereal disease was supposed to be the result of the wrath of God and consequently treated by supplication to the priests, we have had the twins of grief—gonorrhea and syphilis—always with us.

GONORRHEA.

Forty years ago the gonococcus had not been discovered. While the disease was known as gonorrhea and the patient known to have a purulent urethritis, the cause was supposed to be contaminated secretions; but now we all know it to be a specific infection caused by the gonococcus, and long before there are any symptoms of the disease the germ will have found its way between the layers of epithelium into the crypts and glands and probably the subepithelial connective tissue. When the first symptom of irritation makes itself known there has already been a marshalling of leucocytes, the trenches have been formed and the battle of phagocytosis is already on. The trenches are filled with maimed and partially devoured and are soon overflowing, the flood appearing at the meatus, which reminds the victim of some alluring skirt.

The reaction going on in the tissues before mentioned and the outpouring of the leucocytes cause the discharge. This is an effort of nature to rid these tissues of the invading cocci, and so long as this effort is sufficient unto the evil thereof, there should be no interference on our part. It is my opinion that the treatment usually prescribed by our profession for this particular disease is more harmful in the aggregate than no treatment at all.

When the efforts of nature begin to lag is the time for our assistance. When the leucocytes have failed to clear the field of germs it remains for us to increase leucocytosis. Every case of chronic gonorrhea that has come under my observation has passed from the acute stage of the disease by meddling treatment. I cannot believe that there would be one per cent. of the acute cases to become chronic if they were properly managed.

The irrigation treatment so much in vogue today, however hygienically beautiful in theory, is, in my opinion, the cause of many cases of posterior urethritis, prostatitis, vesiculitis and impotence which we see today. Another method of treatment brings to us many cases of those just mentioned. That method is injections of astringents which close and seal the door of escape of the leucocytes, so necessary to rid the infected area of the germs of this disease. When so sealed the germs and their toxins find their way of escape through the lymph channels and avenues of general circulation to find their eternal abiding place or home in the prostate, seminal vesicles or in some remote joint, there to propagate their kind for all time to come. Much harm is produced by the indiscriminate use of antiseptics and the silver salts. While the result obtained by the proper use of silver salts is all that could be desired, let me admonish you not to use them until you have first learned how.

It is not my purpose to go into the detailed medicinal treatment of acute gonorrhea, but these preliminary remarks about its cause and mistreatment seem to be called for by what is to follow.

When the disease passes from the acute to the chronic stage reinfection occurs in the posterior urethra, and in practically all such cases the prostate is involved. At

this time there may be an increase of the discharge or it may entirely cease.

If the discharge and ardor urinæ cease the patient thinks he is well and is often so advised by his physician. After a few weeks, months or years this patient shows up at the office of some other physician with a few or many of the following symptoms: Lumbago, sciatica, pruritus ani, loss of sexual power or, possibly an increased libido, ejaculo præcox, pain in the inguinal region, and if it be on the right side it may simulate appendicitis. He may complain of pain simulating the passage of stone through the ureter. He may have vague gastro-intestinal symptoms, cardiac phenomena, painful muscles or joints. These cases drift from one physician to another and are treated for everything from rheumatism to duodenal ulcer. I have seen cases of prostatitis in which the principal symptom was swelling and pain in the calf of the leg.

I saw a case not long ago in which the only complaint was a pain in the region of the occiput. I have known cases of gonorrheal prostatitis being diagnosed as typhoid fever. Neurasthenia in man is nearly always due to prostatitis, vesiculitis or colliculitis. Many a man has had his teeth extracted when the source of infection was in his prostate. Cases are numbered by the thousands of men who have a concealed gonorrhea, their wives furnishing the material to keep up hospitals and the practice of abdominal surgeons.

Most urologists agree that the treatment of chronic cases should consist of massage of the prostate, dilatation of the posterior urethra, instillations of silver nitrate, hot or cold rectal irrigations and sedative suppositories. Most cases are cured by this method if faithfully and persistently carried out. A proper massage of the pros-

tate is *the* important part of the treatment. It requires some knowledge and practice to properly massage a prostate. Improper massage may cause an acute attack of prostatitis and metastasis to some joint. No man ever lived who can massage a prostate with his finger with as good results as are obtainable from a cellular massage by static electricity. Acute prostatitis should be treated by the application of a high-frequency current through a prostatic vacuum electrode. Chronic cases should be treated by static electricity through a properly formed metal rectal electrode.

The static wave current relieves local hyperemia and congestion, consequently, tenderness and pain. It causes relaxation of muscular spasm, accelerates repair by increase of metabolism, increases glandular activity and promotes absorption. The static wave current, by its pulsatory movement drains engorged tissue and expresses the infiltrate. It increases phagocytosis, thereby relieving infectious inflammations, and it is but natural, being familiar with these effects, that we should use it in gonorrheal prostatitis as well as all other diseased prostates except cancer, calculus and tuberculosis. If there is much fibrosis it should be softened by exposure to x-ray.

A FEW DON'TS.

A few *Don'ts* in the management of acute gonorrhea may be apropos:

Don't fail to examine the meatus and enlarge it, if found to interfere with drainage.

Don't allow your patient to tuck cotton under the foreskin to dam up the urethral discharge.

Don't prescribe an injection until the discharge is on the wane.

Don't prescribe so-called antiseptic injections.

Don't prescribe a silver preparation without first generalizing the disease and individualizing your patient.

Don't expect to kill the germs with any silver preparation.

Don't allow your patient to use a syringe until you are sure he knows how to use it and keep it clean.

Don't prescribe santal oil or other balsamics unless they are distinctly indicated.

Don't expect any results from methylene blue.

Don't expect to cure your patient by irrigating his urethra.

Don't administer Neisserian bacterins unless there is a metastasis of the disease.

Don't prescribe medicated bougies.

Don't pass a steel sound into an acutely infected urethra.

Don't expect to learn how to treat this disease from textbooks.

If you have an acute case of gonorrhea and have practiced all these don'ts, you probably will not have a case of chronic gonorrhea on your hands to require treatment by electrotherapy.

GONORRHEAL PROSTATITIS.

I have treated hundreds of cases of gonorrheal prostatitis with the Morton wave static current with 90 per cent. successful results. If you have no static machine you will succeed in all cases of acute prostatitis with high-frequency and be able to benefit a majority of chronic cases by diathermy (Fig. 85).

No one can have an opinion upon any subject upon which he is not thoroughly posted; he can make a guess but he is not entitled to an opinion.

I feel in duty bound to mention some of the electrotherapeutic methods of treatment of acute gonorrhea, but for the reason just given I have no opinion upon the efficacy of the treatments.

VIRGHI'S TREATMENT.

Virghi proposes the treatment of acute gonorrhea of less than seven days duration, in the following manner: He first washes the urethra with sterile water by syringing. Then he anesthetizes the urethra with 5 c.c. of a 2 per cent. solution of cocain. This solution is expelled and then an injection of a solution of protargol which is

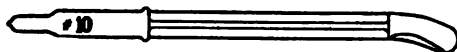


Fig. 85.—Prostatic vacuum electrode, insulated for treatment of prostatitis.

retained in the urethra until the close of the treatment which is as follows: The positive electrode of a galvanic battery is placed anywhere on the left thigh, the negative electrode carrying a ball size 13 or 14 French attached at the tip is passed into the urethra allowing no protargol to escape. The current is turned on and at the same time the operator slowly moves the electrode forward and backward, touching all parts of the anterior urethra in order to conduct the continuous current through the ball which is plunged in the protargol solution. While the amount of current is registered on the milammeter the sensations of the patient are the control.

The maneuvers in the interior of the urethra do not cause any disagreeable sensation. Three minutes suffice for this portion of the séance. At the end of twenty-four hours the procedure is repeated in every detail. Whether

the treatment is repeated depends upon the presence of gonococci in the secretion.

The next stage of treatment consists of daily lavage with a solution of boric acid, followed every two or three days by massage upon a straight sound. If the gonococcus reappears another series of two electrolyses is given in order to rid the urethra permanently of the organism.

Virghi claims 100 per cent. cures by this method. The time consumed by him in each of 92 cases was from three to thirty-three days. He claims that this abortive procedure is the only one which is capable of giving absolutely sure and permanent results in cases of acute gonorrhea of not longer than seven days duration.

ROCCAYROL'S TREATMENT.

Ernest Roccaïrol employs straight or curved urethral thermophores consisting of nickel or silver plated copper tubing in the interior of which are soldered at intervals several insulated wires conducting the current to the thermophore. These thermophores are introduced into the urethra. The other electrode consists of a metallic plate which is placed beneath the buttocks.

An electric mechanism connected with the thermophore, including a galvanometer, is provided in order to obviate heating of the electrode to such a temperature as would injure the urethral tissues. He finds that the gonococcus is killed by temperature exceeding 39° C. Such a treatment lasts twenty minutes. The method is employed in rebellious painful cases of chronic urethritis. He says: "Pain disappears on the first sitting; shreds disappear after a few sittings; infiltrations rapidly disappear but sclerotic changes move slowly."

GEYSER'S TREATMENT.

A. C. Geysler finds that the gonococcus grows best at a temperature of 99° to 104° F. He treats the patient until the urine becomes alkaline, then he inserts an ordinary steel sound into the urethra. This sound is connected to one pole of a diathermic apparatus and the temperature raised to 108° F. This temperature is maintained for an hour or more daily for three days. He claims that this kills the specific cause of the infection. He also injects about 15 drops of colloidal iodine into the urethra and finds that the iodine, becoming heated during the diathermic process, enters the tissues better than an oily or watery iodine or silver solution. After three days all active treatment is stopped.

Ballinger and Elder devised a ball shaped electrode suitable for use with the d'Arsonval current in follicular urethritis. A urethroscope is inserted as far as the bulbo-membranous junction, and the urethra carefully examined as the instrument is withdrawn. When an infected follicle appears the electrode is pushed forward, inserted into the duct and then advanced until a definite feeling of resistance is experienced. The current is turned on for one second. Usually two or three periods are necessary to accomplish the desired result. I have never tried this method, but it appeals to me as being a rational procedure.

Eitner attempted to treat cases of acute gonorrhea by means of diathemy. He applied it for forty minutes duration but did not succeed.

GONOCOCCI AND HEAT.

Santos undertook some experiments to determine the time necessary with different temperatures to kill gono-

cocci. He found that they died in seventy-six minutes at 43° C., in fifty-four minutes at 44° C. and in thirty-seven at 45° C. His experiments on animals and human beings showed that a temperature of 45° and 46° C. were borne for one hour's duration without noticeable discomfort or permanent damage. Santos devised an electrode for use by his method, but I have never seen it.

We have heretofore mentioned the probable concentration of heat at the edge of the electrode, and I am unable to understand how it can be avoided when a solid steel sound is employed.

TREATMENT OF ORCHITIS AND EPIDIDYMITIS.

Gonococcic orchitis, as well as epididymitis, readily yields to diathermy. The technic is as follows: A cup electrode with a metallic connection at the bottom is filled with plain warm water and connected to one side of the apparatus. The other pole is connected with a metal plate upon which the patient sits in such a manner that the perineum comes in contact with the plate. The patient's scrotum is placed within the cup. The current is gradually turned on until a distinct heat is felt in the scrotum and in both sides of the groin.

If salt be added to the water it reduces the resistance and the water becomes cooler, but the parts will become gradually heated. Sugar added to the water increases the resistance.

SEXUAL IMPOTENCE.

In many cases of impotence diathermic applications are of signal benefit. With a metallic electrode in the rectum and a metal electrode over the symphysis pubis, arterial flow of blood will be increased in the parts

affected and relieve the coldness in the parts as well as increase the glandular activity.

There are many conditions that produce sexual impotence, and nearly all of them are amenable to some form of electric modality.

I know of no drug administered for the purpose of increasing libido but what does harm. A whip applied to a tired horse may increase his speed momentarily, but he will be longer in getting to the end of his journey and be much the worse for the whip.

We must thoroughly examine our patients who complain of sexual incompetency, diagnose the particular condition present and treat it with the electric modality indicated.

Vacuum tube treatment through the rectum has proven to be of service in cases of cystitis, but should be given in conjunction with other well-known medicinal measures.

Diathermy is often of signal service in cases of cystitis where there is no hemorrhage.

TREATMENT OF BLADDER PAPILLOMA.

It is not only possible to destroy benign but malignant papillomas of the bladder by the high-frequency coagulation method. The response to treatment, however, in the benign as compared with the malignant is of considerable interest. Tumors that are histologically benign disappear with astonishing rapidity. When, however, the papillomas are malignant, the response may be extremely slow and many times discouraging. Sometimes small malignant papillomas will require many times the amount of treatment necessary to have destroyed a benign papilloma of the same size. In carcinomatous papillomas in which the base is infiltrated, the chances of eradication

of the tumor by this method of treatment are almost *nil*, although considerable symptomatic relief may be obtained. From the standpoint of prognosis it is important to have a knowledge of the nature of the growth. If the growth be malignant, metastasis may be expected.

Recurrences of benign growths are rare, and malignant ones common. This method should be employed in all cases of bladder tumor where the bladder wall is not involved. If cystoscopic examination shows bladder wall involvement it is a case for the surgeon.

In all cases of papilloma of the bladder there is more or less hematuria, and this should be controlled before electrocoagulation is attempted. Nearly all these cases have an alkaline urine, and it is advisable to have the patient in bed a few days under a treatment which will change the urine to an acid reaction. If this does not clear up the hematuria, irrigate with a weak solution of silver nitrate (1 to 5000). If this does not clear the urine use a solution of adrenalin. This clearing of the urine is absolutely necessary in order to have a clear vision of the field to be operated upon. A ureteral catheter carrying cystoscope is the only one which I would recommend. After you have cleared the urine fill the bladder moderately with a solution of warm boric acid.

An electrode made from a ureteral catheter which fits the cystoscope can be readily made by passing a steel wire through the lumen of the catheter in such a manner that the wire will protrude about $\frac{1}{16}$ of an inch. The wire must be of sufficient length to be able to be fed through the catheter as the current eats away the wire very rapidly. The end of the catheter and the wire should be cut square across. Having placed the electrode in position, an assistant will operate the current in the same manner as in desiccation of neoplasms of the skin. The current

should be directed into the base of the tumor and applied until you are satisfied that destruction has taken place. Withdraw the cystoscope, put your patient to bed, administer hexamethylene tetramine and await the sloughing of the tumor. There should be no more hemorrhage.

If the tumor has a small base three seconds are sufficient for destruction and no anesthetic is necessary. If the tumor has a wide base, novocain should be used. I have operated on small papillomas in the office and let the patient go on about his business, but we should never operate on a malignant case in the office unless he can be put to bed immediately. Do not attempt to operate upon these cases until you have become familiar with the use of the cystoscope.

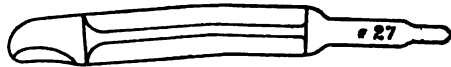


Fig. 86.—Vaginal vacuum electrode, insulated.

DISEASES OF THE UTERUS.

High-frequency currents are suitable in almost all diseases of the uterus and its adnexa. About the only contraindication is a closed collection of pus, which, if present, calls for surgical interference. In acute inflammatory conditions accompanied with pain, an electrode emitting a pinkish red glow is the one of choice (Fig. 86).

When infiltrations and adhesions are to be treated, an electrode emitting a whitish glow should be used. In some cases diathermy is indicated. This may be applied either with a vacuum or a metal electrode in the vagina, the other pole either on the abdomen or under the buttocks. The electrode, whether metal or vacuum, should be insulated. I believe that you will appreciate the technic of operation without any extended description.

I will mention two points which must not be overlooked: Be sure that your electrode is well anchored so that it will not move during the six or eight minutes of treatment; also, be sure that the cord carrying the current does not touch the patient, the chair supporting the patient or the table. Be careful of office chairs made of metal, as the chair may become charged and the patient receive disagreeable shocks.

An electrode made of cotton, filling the vagina, with a wire connection in its center, has been used, but I would not advise it.

In case an intra-uterine application is indicated, an electrode of copper wire, with a slip-on rubber insulation should be employed.

Accessible papillomas of the cervix as well as cervical erosions are amenable to treatment by desiccation.

Anal fissures, unorganized hemorrhoids, fistulas, rectal ulcers and pruritus ani are favorably influenced by high-frequency currents delivered through the vacuum electrode.

CHAPTER IX.

DISEASES AMENABLE TO ELECTROTHERAPY.

ABSCESS.

Abscess is defined as a collection of pus in a cavity, the result of inflammation due to infection with pus forming micro-organisms. An abscess may be acute when due to staphylococci, streptococci and other micro-organisms; chronic when due to a specific microbe as that of tuberculosis.

Abscesses have been classified according to etiology, pathology and location.

Etiology.—The introduction of foreign bodies under the epidermis and inflammation due to traumatism are the chief causes of abscess.

Symptoms.—The symptoms are usually sufficiently clear, but a diagnosis should be carefully made before surgical measures are resorted to as the opening of an aneurism or an important artery might prove embarrassing. Semisolid growths may simulate an abscess.

Prognosis —The prognosis depends upon the general health of the patient, the location and extent of the abscess. Fistulous tracts and large suppurative areas may form which will overcome body resistance and prove fatal from general sepsis. When they are so situated that adequate drainage may be maintained, the tendency is toward recovery.

Treatment.—Treatment may consist of general measures such as favorable position, diet, etc., internal remedies to relieve urgent symptoms and general toxemia. One grain of calcium sulphide every two hours seems

to have an inhibiting effect upon the micro-organisms. External application of remedies such as heat, antiseptic solutions, etc., is often indicated. Abscesses such as boils, carbuncles, etc. may be aborted by early application of the high-frequency current from a vacuum or non-vacuum electrode carrying a current capacity of $1\frac{1}{2}$ inch spark continued for a period of six to eight minutes. If pus has already formed do not employ high-frequency currents before drainage is established. The x-rays will often abort a boil, carbuncle or glandular abscess.

It has been proven over and over again by clinical observation that it is possible to bring about a complete subsidence of suppuration in acute abscess, chronic suppurating fistulous tracts, sinus infections, boils, carbuncles and many other septic conditions by zinc ionization. The action of the zinc is to coagulate the exudate and at the same time the germs are fixed in the coagulum and destroyed and the wound rendered sterile. The success of this treatment all depends upon the thoroughness of the application. If all parts of the pus cavity are reached by the solution one treatment is sufficient.

Technic.—After the abscess has been opened by a small incision and the cavity irrigated, a conical shaped nozzle electrode is introduced (Ionization Electrode No. 1) and the zinc solution kept continually flowing from the reservoir into the abscess cavity for ten minutes. The strength of current should be 8 to 10 milliamperes and employed for seven to ten minutes. In deep suppurating wounds and sinuses a specially devised electrode may be required such as Ionization Electrode No. 2, 3 or some modification of them to suit the conditions. The object to be attained is to keep the solution in contact with all suppurating surfaces during the ionization process. After the ionization is completed the cavity should be filled

with zinc gelatin solution and several layers of antiseptic gauze, a cotton-wool pad and bandage applied. The dressing should not be removed for three days, when the cavity will be found closed. If there be sloughs in the cavity their removal is necessary to success. If for any reason it is found undesirable to remove the sloughs before ionization, the dressing should be sterile vaselin instead of zinc gelatin.

The removal of sloughs and blood clots from large wounds and fistulous tracts may require a general anesthetic. (See "Ionization.")

General Considerations.—Quinine will not cure every case of malaria neither will mercury cure all cases of syphilis. Ionic medication will not cure every case of sepsis, but if properly applied it will clean up suppurating surfaces in a shorter time and with greater satisfaction to the patient and physician than any other method of therapy.

There are several factors to consider in the treatment of sepsis by ionization as well as by any other method of procedure. Is the suppuration limited to a superficial area or are the tissues deeply infected? Has the abscess cavity communicating tortuous channels? Are there important blood-vessels closely adjacent to suppurating surface? Does the abscess communicate with necrosed bone? What is the general condition of the patient?

Where it is a mechanical possibility to reach the entire suppurating area with the ionizing solution the results are prompt and lasting. When the abscess is compound an operation is usually required to convert it into a simple one.

There is no more difficulty in arresting suppuration in bone than other tissues, provided all suppurating surfaces can be reached.

If important blood-vessels are likely to be reached by the ionizing solution, zinc should not be used, as the chlorin set free in the tissues will unite with the zinc radical, forming chlorid of zinc which is soluble and may have a corrosive action on the walls of the blood-vessels and lead to an unpleasant if not a dangerous hemorrhage.

It may be wise to associate ionic medication with other well known medical and surgical treatment. A good physician will generalize the disease and individualize his patient, and choose the line of therapy indicated.

It would be very foolish to expect to close an abscess when necrosed bone covers up a nidus of bacteria without first exposing the nidus to the ionizing fluid. It would be equally futile to employ ionic medication in the external auditory canal for suppurating otitis media if the opening in the drum would not permit the solution to enter the middle ear. It would be also futile to expect results from ionic medication when some distant focus is the etiological factor.

ACNE.

Acne is characterized by the presence on the face and perhaps shoulders and back, of small elevations or nodosities varying in size from a pin head to a pea. Most of these lesions have a tendency to suppuration. In the center of the lesion a whitish-yellow spot forms where the pus raises the epidermis. In the course of a week or ten days the lesion breaks and pus is discharged. At other times the pus dries and forms a crust. A red elevation is left which gradually flattens and leaves a brown stain. The surrounding skin is usually oily and shiny. If nodules form, scarring usually results. In the majority of cases no scar remains.

Varieties.—There are several varieties of acne, the most common being *Acne simplex* or *Acne vulgaris* which consists of blackheads, small papules and pustules. They are discrete and isolated.

Acne papulosa is characterized by papules which have no disposition to form pus and disappear by absorption or exfoliation. When the lesions consist of minute papules and blackheads the term "*Acne punctata*" is applied.

Acne pustulosa is a type made up of papules which pass rapidly into the pustular stage. They are usually of large size.

Acne indurata as the name signifies consists of closely crowded eruption which presents a hard inflamed, indurated base usually deep seated.

Acne medicamentosa is produced by ingestion of certain drugs as iodides and bromides or local application of irritating remedies.

Etiology.—Acne usually appears at about the time of the development of the pilar system and the functions of the sebaceous and sex glands. The lesion is more frequent with patients who have digestive troubles, menstrual irregularities or some diathesis.

Diagnosis is usually easy. It is to be differentiated from syphilis and variola.

Treatment.—The medicinal treatment of acne is general and local. Almost all drugs from tincture of nuxvomica to codliver oil have been tried and found wanting. Local applications from the most soothing to the most irritating have been tried with varied results. Surgical methods are followed by unnecessary scarring.

Ultra-violet rays from a suitable apparatus is said to be beneficial in this disease.

Technic.—Protect the eyes by filling the space below the eyebrows with cotton. Cover all areas not diseased

with cotton or gauze. Express the pus from all pustules and clean the skin with alcohol. Apply rays with the lamp 20 inches distant for one to three minutes. If necessary, repeat the application as soon as desquamation is completed.

High-frequency currents are useful in this disease. *Technic*—Open all pustules with a needle and express the pus with the side of the needle. Apply the current from a vacuum electrode carrying a current of sufficient strength for a 1 inch spark. Keep the electrode on the skin and moving. Sparks should be avoided. High vacuum or non-vacuum electrodes are best. Time of treatment cannot be stated definitely on account of the variation of the sensibility of different patients' skin. Hyperemia is the effect to be desired. Treat every second day until results are obtained.

The ideal treatment for all forms of acne is x-rays by the fractional method. From 1 to 4 exposures are usually sufficient. Some röntgenotherapists prefer 1 exposure of H 1.

If the condition be due to constitutional causes there will be recurrences until the condition is corrected.

Acne may be treated by ionization of sodium salicylate. *Technic*—The skin should be thoroughly cleansed. Soak several layers of gauze with the sodium salicylate solution (2 per cent.) to which gelatin has been added, and apply to the affected area, over this lay a block tin or wire gauze electrode attached to the negative pole and allow a current of 30 or 40 milliamperes to flow for thirty to forty-five minutes.

ACNE ROSACEA.

Acne rosacea is characterized by a chronic congestion of the face, causing vascular dilatations, and by changes

in the cutaneous glands and tissues, giving rise to seborrhea, inflammatory acne and hypertrophic changes. The nose and malar eminences are favorite areas for this disorder. There are three forms of acne rosacea, *viz.*: true acne rosacea in which papules and pustules are added to the erythematous and congestive features; erythematous and telangiectasic characterized by congestive spots on the face especially on the nose. These forms may or may not be accompanied by seborrhea. The nose may become violet-hued and cold. The congestion is due to a network of vascular dilatations. The third form is known as *hypertrophic acne* or rhinophyma in which the glandular orifices are enlarged, the tissue around them proliferate forming a variety of *pachyderma*. The nose is usually dark red, covered with enlarged orifices and greatly increased in size.

Treatment.—The treatment of acne rosacea by drugs is practically without avail. Ultra-violet rays from a quartz applicator is useful in this condition; x-rays in small fractional doses is very effective. Electrolysis is satisfactory in results but tedious of application. It must be used with great care to prevent scarring.

Technic.—In hypertrophy of the nose a fine needle is inserted into each follicle in the same manner as in hypertrichosis. The positive pole may be held in the patient's hand; current strength 3 to 5 milliamperes is required. To obliterate the dilated vessels a fine platinum needle should be employed. The needle is inserted along side of the vessel and possibly into it, and connected to the negative pole, and a current strength of 3 to 5 milliamperes employed for sufficient time to blanch the tissues. Papules and pustules are best treated by x-rays in fractional doses or one treatment of the intensity of H 1.

ACTINOMYCOSIS.

Actinomycosis is a parasitic, infectious and inoculable disease due to actinomyces or ray fungus.

Symptoms.—These vary according to the locality of the disease. The affection is chronic. It is characterized by an abundance of granulation tissue: it is quite firm and surrounded by diffuse edema. Where suppuration occurs the mass increases rapidly in size. The pus contains characteristic yellow grains. The infection may manifest itself in almost any part of the body. The favorite localities are the skin, mouth and intestines.

Prognosis.—Internal actinomycosis is usually fatal. External actinomycosis may cause death from pyemia. When so situated as to be treated early the prognosis is favorable. When the primary focus is destroyed recovery usually follows.

Treatment.—A few cases of actinomycosis recover under treatment by large doses of KI. When the lesion is accessible and primary it usually yields to fractional or intensive treatment by x-ray. Electrolysis has proved successful in some cases.

Technic.—With patient under an anesthetic two platinum needles attached to the poles of a direct current are inserted into the tumor through which 50 milliamperes of current are passed. During the passage of the current a solution of 10 per cent. KI is injected into the mass. The KI solution is ionized and destroys the fungus. This treatment may have to be repeated in eight days. The tumor may also be destroyed by the electro-coagulation method with the same technic as for cancer. If recognized very early a resolution may be brought about by desiccation or fulguration.

ADENITIS.

Inflammation of a gland may be acute, due to infection, but occasionally to injury. Irritation sometimes results in enlargement and induration.

Adenitis may be caused by contact with a neighboring inflammation; by continuity or following lymphangitis; by embolism due to transportation of septic matter produced in the system or coming from the outside. It occurs in carbuncle, furuncle, vaccination, erysipelas and infectious fevers, syphilis, gonorrhea and tuberculosis.

Suppuration does not always occur: resolution may take place or chronic enlargement follow. If suppuration does occur the surrounding connective tissue usually suppurates along with the gland. Sometimes the periglandular tissue suppurates and the gland does not.

Prognosis.—Usually favorable, but may be unfavorable when extensive abscesses form in the neighborhood of important organs.

Treatment.—Regardless of the cause of adenitis, the gland, if accessible, should be exposed to an intensive treatment of x-rays. If applied early resolution will take place. If suppuration has taken place it should be treated by zinc ionization, employing the same technic as for abscess.

ALBUMINURIA.

Albumen may be present in the urine under various circumstances. It is no longer in itself considered a symptom of disease, as it is generally admitted that albuminuria may be compatible with perfect health. Different kinds of albumen may be present in the urine; generally the proteids contained in the blood serum are to be found, *viz.*: serum-albumen, globulin, hemialbumose, nucleo-albumen and pepton. The first two are important

because of their association with nephritis. Serum albumen in the urine may be due to renal disease or to the presence of pus, blood, spermatozoa or tumor elements. Urine containing these substances will give the albumen reaction.

Renal albuminuria may be due to febrile diseases, disease of the central nervous system, toxemia, pregnancy, long continued exposure, empyema, crisis of pneumonia, violent exertion, phosphorus poisoning and carcinoma.

From a pathological point of view the causes of albuminuria may be due to disturbances of circulation; changes of the tubular epithelial cells or walls of the blood vessels of the kidney and changes in the composition of the blood.

Treatment.—The treatment of albuminuria depends entirely upon the origin and cause. When due to nervous disturbances, pregnancy, toxemia and early circulatory changes much may be done by the application of high-frequency currents in the form of auto-condensation and diathermy.

Every case of albuminuria due to kidney changes is preceded by and accompanied with hypertension. The sphygmomanometer will tell us of the approaching albuminuria of nephritis long before albumen can be detected in the urine. If the early hypertension be corrected nephritis may be prevented.

Static electricity, the great nerve stabilizer, will often cause the albumen to disappear from the urine even when due to nephritis. This has been proven in many cases by Neiswanger and myself as well as others. Neiswanger says: "Static electricity is the logical remedy, because the evolution of oxygen, always accompanying this modality, not only hastens the elimination of waste matter but gives

a better tone by its vibratory action, to the nerve centers affected."

Dr. Neiswanger's technic is as follows: Negative head breeze for fifteen minutes, followed by positive insulation for the same time. The static wave current to spine is alternately substituted for the head breeze. Treatments are given daily.

My technic is somewhat different from that of Dr. Neiswanger and depends upon the condition of the patient at the time of beginning treatment. When the condition is accompanied with very high blood-pressure, say above 180 systolic, the patient is given auto-condensation daily until the blood-pressure is markedly reduced, then he is given static insulation on alternate days with static wave, with electrode over the 4th and 5th dorsal vertebræ. Whenever the blood-pressure again approaches 180 systolic, auto-condensation is again administered until the pressure is reduced, when static treatments are resumed.

In cardio-renal conditions accompanied with waterlogged tissues, diathermy of the liver and kidneys often yields surprisingly favorable results, but under such conditions relief only is to be expected. If at the beginning of treatment the blood-pressure is found to be 150 or under the patient is given static treatment only.

Static machines are not frequently found with the office equipment of physicians, and to those who do not possess them allow me to suggest as next in order of usefulness, auto-condensation in hypertensive cases and diathermy of the kidney and liver in cases of but slightly increased pressure. Vibration and unipolar application of the high-frequency current from a non-vacuum or vacuum tube over the 4th and 5th dorsal vertebræ are useful in correcting the nervous dysfunction. The high-fre-

quency breeze from a multiple-point electrode to the spine is very gratefully received by the patient.

The treatments mentioned in no way interfere with medicinal or hygienic management, but the physiotherapeutic management as mentioned is far superior to all other methods of treatment known to us today.

ALOPECIA.

Alopecia is a term applied to partial or general falling of hair. There are several varieties: The pathological, due to a general morbid condition and which may be acute or chronic, the acute form occurring during convalescence from typhoid fever and the exanthemata, while the chronic form may be due to poor general hygiene, struma, mercury poisoning, diabetes, syphilis, tuberculosis, anemia or cancer; local alopecia due to diseases of the scalp, such as erysipelas, eczema, seborrhea, psoriasis, impetigo, etc.; senile alopecia, which may begin at the age of 45 or 50 and sometimes earlier.

Etiology.—Among the causes of alopecia that may be named are: Prolonged debilitating influences, excessive mental labor, overeating and other excesses; interference with circulation in the scalp by a stiff or tightly fitting hat; peripheral dental nerve irritation; too frequent washing of scalp, etc.

Pathology.—Alopecia may be considered a microbic affection. Alopecia of convalescence is due to disturbance of nutrition of the tissues. When due to chronic general diseases the hairs are no longer formed, the roots become atrophied and the hair falls out. When it reaches the follicle the bacillus of seborrhea produces a sebaceous hypersecretion, sebaceous atrophy, papillary atrophy and death of the hair. Common baldness is the result of a chronic fatty seborrhea. *Acute alopecia areata* is due to

a local seborrheic infection. In chronic alopecia areata the infection of the hair follicle is a permanent one.

Prognosis.—In senile alopecia the prognosis is unfavorable—no chance of a cure. Following acute diseases the prognosis is good. In chronic general diseases the prognosis is unfavorable. Syphilitic alopecia when not due to a local lesion is soon recovered from by specific treatment. If due to a local lesion affecting the hair follicle it is usually incurable.

Treatment.—The ordinary medical treatment consists of the administration of iron, quinine, strychnine, arsenic and mercury in connection with local applications of many kinds of irritants. The physiotherapeutic method of treating the disease is most rational. The first indication is to kill the bacillus which is most effectually accomplished by x-rays. If the rays be too intense they act as a depilating agent. The fractional dose method is to be applied just enough to act as a germicide, say $\frac{1}{4}$ to $\frac{1}{2}$ H. at intervals of one to two weeks. The rays not only kill the bacillus but act as a stimulant to the hair follicle if there be any to stimulate. The stimulating effects of ultra-violet rays are also known to be of service in this affection.

Technic.—Distance of lamp 15 inches; time of exposure three minutes, add one minute to each subsequent treatment until the maximum of ten minutes is reached; frequency of application, two to three days.

The treatment by high-frequency currents should be sparks from a vacuum electrode. The applications should be of sufficient strength to produce a very active hyperemia and be repeated three times a week.

AMENORRHEA.

Amenorrhea is defined as an absence of the menstrual flow in women of suitable age who are not pregnant. The term is also applied to suppression of menses through some local or general disorder. Amenorrhea may be *complete* when the menstrual flow has ceased; *comparative* when it appears occasionally; *primary* when menstruation does not appear at the age of puberty nor subsequently; *secondary* or *accidental* when, having already appeared, the flow ceases.

Symptoms.—Suppression of the menses when due to some general disorder seldom gives rise to any symptoms except the one that is evidenced by absence of menstrual flow. When, however, it is due to local disturbances the symptoms of congestion of the genital tract appear, soon followed by an inflammatory process which may be local or general. Peritonitis sometimes results from the process. Remote symptoms of a nervous character are usually present such as headache, nausea, backache, hot flashes and hysteria.

Etiology.—The causes of primary amenorrhea are due to imperfect or insufficient development, imperforate hymen, anatomical imperfections and anomalies such as absence of genital organs. Amenorrhea frequently occurs after a serious illness or during the course of a chronic disease such as diabetes, cancer, pernicious anemia and tuberculosis. Secondary amenorrhea is often due to exposure to cold. Any lesion of the genital apparatus may cause amenorrhea especially metritis, endometritis, parametritis and malposition. Cystic degeneration and atrophy of the ovaries, and adhesions due to previous pelvic peritonitis are sometimes the cause of hyperinvolution of the uterus following pregnancy.

Diagnosis.—Amenorrhea must be distinguished from menstrual retention due to atresia of the cervical canal, vagina or vulva, or imperforate hymen. A thorough examination of the pelvic contents is necessary in every case.

Treatment.—The medicinal treatment of primary amenorrhea is absolutely useless. Secondary or accidental amenorrhea is often relieved by drugs. When due to some chronic disease outside the local conditions, general medicinal or hygienic management is required. Treatment by electricity constitutes the most efficacious method known for amenorrhea not dependent upon an organic irremedial cause. When amenorrhea is due to faulty metabolism, beneficial results should obtain from auto-condensation and diathermy. Before employing electricity in any form, be sure of your diagnosis and be satisfied that electricity is indicated.

One of the greatest causes of sterility is the infantile or undeveloped uterus. The treatment for this condition by the softening effects of negative galvanism followed by the sinusoidal or Bristow coil current with the same technic as in cervical stenosis is signally successful in increasing the size of the uterus and restoring normal menstruation. This technic is neither practical nor advisable in the unmarried, consequently the percutaneous method of application is employed, the technic of which is positive electrode over the sacrum with negative over the hypogastrium with a current of toleration for ten minutes, followed by slow sinusoidal for three minutes. The treatment should be repeated every third day. In cases of transitory amenorrhea in the married the following technic often yields the desired result: With a large positive electrode over the hypogastrium an intrauterine electrode is passed into the uterus and a current of 30 milliamperes

passed for a period of five minutes. This treatment should be administered at the time the menses are expected. This application like all others where the negative pole is employed as the active one should be made under aseptic technic.

In cases of amenorrhea with uterine flexions, adhesions, vasomotor disturbances and anemic conditions, the technic should be as follows: With a large positive electrode on the abdomen and negative connected to a cotton covered vaginal ball electrode placed in the vaginal fornix, turn on a current strength of 40 to 50 milliamperes for ten minutes. Treatment should be repeated every second or third day for a period of three weeks. In case there be an active inflammation in the uterus or its adnexa, the positive pole should be the active one as the negative would aggravate the inflammation. Positive galvanism decreases and negative galvanism increases menstrual flow. Negative galvanism will not cause inflammation but will aggravate it. Positive galvanism will reduce active inflammation, but has a tendency to cause adhesions. However, such adhesions may be removed by the softening effects of the negative pole.

When electro-physiology is understood it is very easy to apply galvanism correctly and with beneficial results in all uterine and ovarian dysfunctions.

AMERICANITIS.

Americanitis may be defined as a nervous insolvency brought on by heavy business cares, bad habits, haste, worry, dissipation, lack of proper exercise, neglect of nature's phone calls, etc. This condition bears a close relationship to neurasthenia.

Treatment.—Success in treatment depends upon the correction of bad habits, hope, inspiration and restoration

of glandular functions. Physical measures combat the conditions better than drugs. In these cases it is best to generalize the condition and individualize the patient. The suggestions made in the management of neurasthenia are apropos in this condition. (See "Neurasthenia.")

ANEMIA.

Anemia is a symptomatic disorder of the blood characterized by a deficiency of some of its important constituents. Benign anemia presents three different types: (1) anemia from hemorrhage where all the blood elements are reduced; (2) deficiency of hemoglobin; (3) deficiency of red blood-corpuscles.

Symptoms.—The symptoms are characteristic.

Diagnosis.—Simple benign anemia should be differentiated from the severe forms, chlorosis, pernicious anemia and leucocythemia.

Chlorosis.—The greenish pallor of this disease is characteristic. The reduction of hemoglobin is disproportionate as compared to the number of red cells.

Pernicious Anemia.—The lemon-colored skin is quite distinctive. A thorough examination of the blood is required to establish a diagnosis.

Leucocythemia.—A microscopic examination of the blood will show an increase of white corpuscles, their ratio to the red cells being all out of proportion to the normal.

Etiology.—The principal causes of simple anemia are hemorrhages, improper assimilation of nutritive products and abnormal expenditure of blood constituents as in pregnancy and lactation.

Treatment.—The treatment of anemia may be summed up as follows: (1) removal of cause; (2) hygienic measures; and (3) proper medication. The administration of

iron and arsenic is of prime importance. When due to faulty metabolism, auto-condensation unless contraindicated by hypotension, is beneficial. Diathermy of the bones of the thigh will increase the red corpuscles and hemoglobin. In cases with hypotension a vigorous application of high-frequency current from a body electrode, preferably a non-vacuum electrode, to the dorsal spine is of service.

General radiation of actinic rays over the entire body improves the general vitality and it is but rational that they be employed with benefit in anemic conditions.

ANEURISM.

It is unnecessary to take the time to discuss the etiology, symptoms and pathology of a dilated, sacculated or indurated artery.

In all the ages gone, men have told us *about* aneurisms, but until recently none have been able to tell us what *to do* for them.

Dr. Albert Abrams has made exhaustive studies of aneurysmal conditions and his conclusions are such as to demand more than a passing notice. He has proven over and over again that aneurism of the aorta can be clinically cured. He makes no claim to a restoration of the pathological changes to normal, but when his method of treatment is faithfully carried out by others and results in the disappearance of the subjective symptoms and the patient returns to his former efficiency it seems well for us to give some credence to his statements.

In his book on "Spondylotherapy" he says: "It occurred to the writer when he first employed the aortic reflexes in diagnosis that if concussion of the 7th cervical vertebra would cause contraction of the aneurysmal sac, this fact would prove advantageous in the treatment of

thoracic aneurism. The results achieved have exceeded his expectations."

The treatment may be administered by any suitable apparatus that will give a hammer stroke. In the absence of an apparatus, a plexor and pleximeter may be employed. The percussion stroke may be delivered directly to the spine of the 7th cervical vertebra or indirectly through a strip of rubber or linoleum. The rapidity of the stroke employed by Abrams is about 150 per minute for a period of from five to fifteen minutes with several interruptions to avoid irritation of the skin. The treatment is given every day.

My experience with this treatment for aneurism is very limited. In the few cases where I have employed the Abrams method for dilatation of the thoracic aorta, the subjective symptoms have disappeared.

In July, 1919, I was called to see a farm hand, age 45. His family and personal histories were good. There was no evidence of specific infection; the Wassermann test was negative. He was suddenly seized while at work, with a sharp pain in the mediastinum followed by syncope. He was carried from the field to his bed. A physician was called, at which time the patient complained of severe pains radiating through the left shoulder and arm. The condition was diagnosed as brachial neuritis and aspirin prescribed. He did not improve and called in several physicians who agreed that he should remain in bed. His pain gradually subsided but on assuming the erect or sitting position the pains would recur.

He had been in bed about two months when I was called in consultation with the attending physician for an opinion as to the advisability of the use of some form of electricity.

The patient was fairly well nourished and when at rest was comfortable; pulse 96, but on assuming the sitting position in bed the pulse increased to 120 and pains would shoot through the shoulder and arm. Physical examination revealed an increased area of dulness over the arch of the aorta. With patient in sitting position and the attending physician's finger on the pulse, I percussed the 7th cervical vertebra 120 strokes in one minute when the frequency was reduced to 96. The percussion was repeated at a rate of about 96 per minute for two minutes when the attending physician called my attention to the fact that his pulse was going lower and lower. I counted the pulse and found it full and steady at a rate of 80. I advised a repetition of the concussion twice daily at a rate equal to that of the pulse.

The treatments were continued for two weeks when he took the train for an eastern city where he remained for three months. On his return three months later he resumed his former occupation. He is able to do a fair day's work, but occasionally has a return of the pain in the shoulder and arm which disappears after percussion of the 7th cervical vertebra for one minute.

This treatment is not empirical but founded upon scientific principles. By percussion of the 7th cervical vertebra the vagus is stimulated, and through the effects of the stimulation the heart beat is lowered in frequency and at the same time the aorta is contracted.

The sinusoidal current will accomplish the same results when applied to the space between the 7th cervical and first dorsal with opposite electrode over the sacrum.

Much has been said and written on wiring sacculated aneurisms. The consensus of opinion is that it is useful in selected cases.

A gold wire with alloy of platinum is fed into the aneurysmal sac and the wire attached to the anode of a direct continuous current. The current is turned on gradually until 40 to 45 milliamperes is reached then gradually reduced to zero so that from forty-five to ninety minutes are consumed in the treatment. The operation should not be undertaken by anyone until he has been thoroughly trained in the technic by a practical operator.

ANGINA PECTORIS.

The term "angina pectoris" signifies a paroxysmal, intense, strangulating pain and oppression about the heart. True angina pectoris is associated with and dependent upon organic disease of the heart.

Symptoms.—The symptoms usually occur suddenly after excitement or exertion and consist of an excruciating pain under the sternum accompanied by a sense of constriction as if the heart were in a vise. The pain usually radiates through the shoulder and down the arm. The pain may be confined entirely to the arm or side of the neck. A sense of numbness accompanies the pain. There is also a sense of impending dissolution. An attack may prove immediately fatal. Successive paroxysms occur with gradual increasing readiness. When dilation of the heart supervenes the attacks may subside.

Diagnosis.—True angina pectoris is always associated with cardiac lesions, especially of the coronary arteries. It should be differentiated from false angina which includes intercostal neuralgia, gastralgia, cardiac asthma, hysteria and tobacco heart.

Etiology.—The predisposing causes are overindulgence in eats, alcoholism, syphilis, gout, diabetes, chronic nephritis and persistent hypertension. The exciting

causes are overexertion, excitement, digestive disturbances and Americanitis.

It occurs more frequently in males than females and between the ages of 40 and 50.

Prognosis.—The underlying condition is apt to prove fatal at any time, but careful management may prolong life for many years.

Treatment.—The attacks usually occur at night and result in an emergency call. Emergency remedies such as nitrite of amyl and nitroglycerine, which will dilate the arterioles and relieve spasm, should be administered. Inhalation of ether or a hypodermic of morphine may be called for. Each case should be treated as the symptoms at the time demand.

Between the attacks all exciting causes should be avoided. If there be hypertension it should be treated by auto-condensation—the only vasodilator that may be employed with impunity. Diathermy applied directly to the heart will often regulate arterial tension. Arterial dilatation within the heart muscle will increase capillary efficiency and thereby improve the nutrition of the heart muscle, allowing the coronary arteries to resume their function.

The *technic* of cardio-diathermy is as follows: Two electrodes not less than 5 inches in diameter are employed, one directly over the heart and the other directly opposite on the back. Small doses (400 to 600 milliamperes) should be used at first and increased to 1000 milliamperes or more as indicated. Time, usually ten to twelve minutes. Vibration or percussion of the lower dorsal vertebræ may be of service.

ANGIOMATA.

Angiomata usually spoken of as "strawberry marks" or patches consist in a dilatation and reproduction of new blood-vessels, the process giving rise to a reddish and slightly elevated tumor. They are usually congenital and their growth takes place in later life. In the early stage they are easily destroyed. Later they proliferate and extend in area. They may involve as much as one-half the face and neck. They are composed of capillaries and veins. The arteries do not proliferate.

Cavernous angiomata are dilatations of venous capillaries into large vascular cavities; they assume a bluish color and are compressible. When allowed to remain they steadily enlarge.

Treatment.—The objects to be attained are the coagulation of the blood in the tumor, the destruction of the dilated vascular walls and preservation of the overlying skin. The technic employed by G. Benton Massey is as follows: In small angiomata the negative pad is placed on the back. The positive pole is attached to a fine platinum-iridium needle which is insulated to near its tip with fused hard rubber or shellac so it may be inserted through the healthy skin just beyond the growth, the bare tip alone to be carried within. A current of 20 to 25 milliamperes is turned on and maintained for four and one-half minutes. Judgment must be exercised as to strength and duration of the current. The current must not be strong enough to destroy the overlying skin.

In large angiomata a number of positive needles may be employed. The negative pole may be a steel needle which is also inserted in the growth. The success of the treatment depends entirely upon carefulness in the matter of technic. Dr. Wm. Clark, in large cavernous angiomata, employs needles of radium.

In small tumors the electro-coagulation treatment is employed, but it has the disadvantage of producing scars. X-rays are of little use in this affection. In portwine marks the ultra-violet rays from a quartz applicator will sometimes coagulate the blood and obliterate the enlarged vessels, leaving no scar.

APPENDICITIS.

It is well known that many cases of catarrhal appendicitis recover under medicinal treatment. The same class of cases are benefited by diathermy and unipolar application of the high-frequency current, but it is usually an unsafe procedure. My advice is to turn such cases over to the surgeon.

ARTERIOSCLEROSIS.

Arteriosclerosis is a condition in which the walls of arteries are thickened, due to morbid changes in the intima which result in narrowing of their lumen. There are three varieties: The nodular, in which the changes are localized; the senile, due to physical degeneration attending old age; the general form which occurs in middle life as a result of various etiological factors.

The symptoms, etiology and treatment of this condition are discussed under the head of "Hyperpiesia."

Treatment.—The treatment of this disease resolves itself into one of hygienic and physiotherapeutic management. We know of no remedy for these cases that equals auto-condensation. Advanced cases may be accompanied by hypotension, in which case auto-condensation is contraindicated. While these cases never get well many years of usefulness may be added to their lives by teaching them how to live and keeping their blood-pressure below the point of danger from cerebral accident.

ARTHRITIS.

Arthritis from the standpoint of causation consists of three forms or varieties, *viz.*: Acute infections, chronic, toxic and traumatic.

Arthritis is essentially an inflammation of an entire joint. Synovitis is an inflammation of the synovial membrane only. A synovitis may extend to and involve the capsule, cartilages and bone. When these conditions prevail it is no longer a synovitis but a true arthritis. The diagnosis is easy, the prognosis reserved, treatment more or less unsatisfactory and results uncertain. The management of cases of arthritis requires the utmost skill, patience and perseverance. We have learned a great deal about the management of these cases through the experiments carried on in the departments of physiotherapy of the military hospitals of the recent world war. The treatment of the various arthritides by serums, vaccines and drugs is admitted by medical men to be at least unsatisfactory.

The physiotherapist has a right to be enthusiastic because the results obtained by his methods are monuments that mark the progress made in the management of this disease.

The cure of any condition consists of the removal of the cause and the restoration of normal function. There are few cases of chronic arthritis cured, but thousands are arrested by removal of the cause and restoration of function to the degree permissible by the destruction of the anatomical structures.

Dr. C. M. Sampson, Capt. M. C., Chief of Physiotherapy service in U. S. A., General Hospital, Fox Hills, Staten Island, N. Y. says: "Chronic processes seldom tend to resolve. Acute processes often do. Therefore,

if we wish to cure a chronic process we must find a way of rapidly clearing up an acute process of the same kind and then do something to create an acute process out of the chronic." (This reminds one of the fellow who said "if you can throw him into fits I can cure him.") Captain Sampson put his theory into practice in treating traumatic arthritis by physical methods and the results were prompt and lasting.

The first step in the treatment of these cases by physical methods is the production of hyperemia which may be done with super-heated air, radiant heat or diathermy. The condition present in each case will suggest the proper form for that particular case. The intestinal tract should be cleaned out and kept clean. The next step is the application of the blue pencil discharge from the static machine for two or three days. This is followed by the indirect spark covering the entire area of the joint and spasmodic muscles. Then the static wave is applied through a block tin electrode for fifteen or twenty minutes. If the x-ray shows deposits of lime to be present, the joint is ionized with a 2 to 4 per cent. solution of NaCl before the static treatment is applied. Every other day the patient receives auto-condensation alternated with electric light bath and a douche or spray. This treatment is employed for the purpose of keeping up the patient's elimination. Massage and manipulations assist the work of other physical measures.

Time and dosage in diathermy treatments are very important. 1000 milliamperes for each 16 square inches is the usual dose, but is often exceeded. The time employed in the hospitals is twenty minutes, but 40 or 60 would be better.

Capt. Sampson says: "After several years previous experience and intensive experience with hundreds of

cases in an arthritic hospital in the service we are willing to state that the treatment outlined gives results superior to anything or everything else we have ever used, ever seen or heard of being used."

Chlorin ionization (2 per cent. solution NaCl) sometimes acts like magic. Heavy currents of 50 to 60 milliamperes should be employed for 30 to 60 minutes.

Gonorrheal Arthritis.—The prostate should be treated by the static wave current. (See "Treatment of Prostatitis.")

ASTHMA.

Asthma is an essential neurosis characterized by paroxysmal dyspnea due to spasmodic narrowing of the bronchial lumen alternating with spasm of the muscles of the thorax. The term asthma is applied to the symptoms just mentioned where no organic lesions can be recognized in its causation.

Asthmatic attacks are caused by irritation of the vagus nerve and may come from any point of its distribution. A frequent point of irritation is to be found in the nose. This may be determined by packing the nostril with cocaine cotton or spraying into the nostril a solution of cocaine during the paroxysm. The point of irritation may be bronchial due to bronchitis. If bronchial râles disappear upon the inhalation of amyl nitrite, they are due to spasm, if they persist they are due to bronchitis.

The causative factor may be due to indigestion, enlarged liver, nephritis, malaria, hysteria, sexual perversion or heart disease. Certain odors and plant flora and animal dust may induce a spasm. Sometimes suggestion will precipitate an attack in which case suggestion will prove to be the proper remedy. Asthma may result from a condition of autotoxemia which a brisk cathartic will

cure. Attacks may occur from pressure of an aneurism, goiter, glandular enlargement, growths in the larynx and foreign bodies. A diseased spine, mediastinal tumors and tuberculosis may be causative factors.

Treatment.—The Abrams method of treatment consists of the provocation of lung reflex of contraction which may be brought about by concussion of the spines of the 4th and 5th cervical vertebræ. This maneuver may relieve the paroxysm. The prime object of treatment is the removal of the cause of the irritation. When it is found in the nose, it may be removed by surgery, ionization of zinc, fulguration, etc.

When no cause is discoverable the sinusoidal current will, in the majority of cases, not only relieve the spasm but by a continuation of its application cause a disappearance of the symptoms, the technic being as follows: Place one electrode over the 4th and 5th cervical vertebræ and the other over the sacrum, and administer a strong wave current for fifteen to thirty minutes and possibly longer, every other day until the paroxysms cease. In case this method does not give relief, the bronchoconstrictor fibers may be more vigorously excited by interruption of the current at the cervical electrode. The same results may be obtained by the inhibiting effects of 8 to 15 minims of a 1/1000 solution of adrenalin chlorid given hypodermically. The adrenalin treatment is in no way curative but will give prompt relief. Lung contraction may be promoted by the patient blowing through a tube. While this maneuver may precipitate an attack, if practiced daily will relieve the bronchospasm.

When the spasm is due to bronchitis there is no treatment as satisfactory as diathermy with the same technic as in bronchitis.

The unipolar application of the high-frequency current over the cervical region and anterior part of the chest often gives relief in neurasthenic cases. General radiation of the body by actinic rays is said to be useful in this condition.

ATAXIA (Locomotor).

This is an incurable disease, but much relief of symptoms may be obtained by the static wave current applied to the dorsal vertebræ and epigastrium. Auto-condensation gives relief in some cases, but a dose of 400 milliamperes should not be exceeded in any case. High-frequency sparks from a vacuum or non-vacuum electrode applied to the legs and pelvic region often give relief.

ATHETOSIS.

Athetosis is a nervous disorder characterized by involuntary movements of muscles apparently of uniform and systematic character. The movements are usually confined to the fingers and toes, but may affect all muscles of the body. The movements simulate those of chorea, but may be differentiated from the latter by *slow* movement, while in chorea the movement is quick and jerky.

Etiology.—The causes of this affection are obscure but are thought to be due to some lesion of the optic thalamus, such as embolus or tumor.

Treatment.—The condition is usually regarded as incurable, but some cases are relieved by galvanism, consequently it is worthy of at least a trial.

Technic.—Negative pole to cervical vertebræ and positive on the forehead. Employ a current strength of not more than 4 milliamperes for three to five minutes daily—or positive pole to cervical region and negative to the hand or foot of the affected side.

ATROPHY, MUSCULAR

When a motor nerve is severed the muscle which it supplies becomes inactive as far as contractile function is concerned and muscular atrophy ensues. When a muscle is inactive there is very little flow of lymph through it, consequently its nutrition is impaired. Anything that will promote the nutritive changes in the muscle is indicated.

Muscular atrophy should be prevented by systematic exercise through the Bristow coil or sinusoidal current. Muscles which show the reaction of degeneration do not respond to the faradic current in which case it becomes necessary to employ the interrupted galvanic, the rhythm of which must be regular with a period of rest.

The sensation of pain produced by electric currents depends upon the height of the current wave, the higher and longer the wave the greater the degree of pain. Uniform rapid (200 or more) interruptions are best tolerated, but care should be exercised not to tire nor tetanize the muscle. In case the muscle responds to faradism, the Bristow coil or the sinusoidal current should be employed with a moderate wave and uniform interruptions. Neither of these currents when properly used causes pain. The treatment should be preceded by a thorough warming of the part by diathermy or radiant heat.

ATROPHY OF OPTIC NERVE.

Treatment.—If seen early much may be done by pneumo-massage for three minutes followed by negative galvanism for ten minutes over the eyelids. A mild current of 2 to 4 milliamperes is sufficient and should be applied every day for two weeks then every second day for a period of three months.

This condition is also treated by a very light high-frequency current from a small vacuum electrode applied over the eyelid three minutes daily for a long period of time.

BRONCHIECTASIS.

Bronchiectasis is a term applied to a condition of a more or less uniform dilatation of the bronchial tubes of one or both lungs. It practically always follows a prolonged bronchitis, whooping cough, pleurisy or pneumonia. The condition is accompanied with a copious expectoration of a fetid character. There is usually an irregular temperature of a remittent or intermittent type.

The conditions from which it must be differentiated are tuberculosis and empyema. Tuberculosis is generally located at the apex of the lung, and when in the stage which simulates bronchiectasis, bacilli are usually present in the sputum. The lesions of bronchiectasis are more widely diffused than in tuberculosis and involve the base of the lung.

In circumscribed empyema there is a clear history of acute onset, the dyspnea is not of long standing and distinct dulness over the purulent area serves to indicate the condition present. An x-ray examination will be of service in making a diagnosis.

Treatment.—In addition to the ordinary medicinal treatment, percussion of the 4th and 5th cervical vertebræ for the purpose of exciting the reflex of lung contraction and the sinusoidal application as mentioned in the treatment of asthma should be employed. Diathermy as employed in pneumonia and bronchitis will be found to be of signal service.

BRONCHITIS.

Bronchitis is an inflammation of the mucous membrane of the bronchi usually due to micro-organisms. In practice we are interested in two forms, the acute and chronic. The chronic form may follow the acute or be chronic from the first. It is unnecessary to discuss the symptoms, etiology, etc., as it is a disease easily recognized but often mistreated.

Treatment.—Acute bronchitis is promptly relieved by diathermy if applied during the first 24 hours after its onset. If treated the first day, one diathermic treatment usually suffices. After the first day two or more treatments may be required.

Technic.—Place a large electrode on the back part of the chest and another of the same area over the sternum and turn on a current strength of 300 to 500 milliamperes for five minutes, gradually increase the milliamperage to 1000 or 1500 for fifteen minutes or longer. Then put the patient in bed, there to remain until next morning, and if not well repeat the treatment.

The same technic applies to chronic bronchitis, but will require several treatments to subdue the disease.

BOILS, BUBO.

See "Abscess."

BRUISES.

Bruises differ in severity according to the degree of traumatism. In light bruises the skin alone may be injured, in more severe ones the soft tissues, and in most severe bruises the periosteum and bone itself are injured. Many cases of apparently mild bruises are passed off as of little consequence which later on result in serious conditions. Who has not seen serious consequences result from an apparently light bruise to the tibia, knee and

elbow? Not infrequently periostitis, osteitis and necrosis follow mild traumatism. The capillary and venous stasis lies at the foundation as a causative factor of all succeeding results.

From a medical standpoint every bruise should be regarded as serious and every effort made to restore normal circulation at the earliest possible moment.

Many years ago, before the evolution of high-frequency currents, those who were familiar with the physiology of the galvanic current were able to restore circulation to enfeebled parts by the application of negative galvanism. While the galvanic current has more or less been superseded by high-frequency currents the latter have in no way lessened the value of the old current.

"Safety first:" Treat all mild bruises as if serious consequences are to be expected. Apply radiant light and heat as soon as possible after the trauma. The success of radiant light and heat lies in prolonged exposure. One hour twice a day is the least time that should be consumed in its application. Between the exposures to light, an application of high-frequency vacuum or non-vacuum current should be applied. Later on the static wave current is efficacious in removing the exudate.

Actinic rays are also useful, especially in infected bruises.

Technic.—Lamp 24 inches distant; expose three minutes, increase one minute each subsequent treatment. Treat every other day. (See "Trauma.")

BURNS.

The healing of severe burns may be accelerated by unipolar application of the high-frequency current through at least one layer of gauze. Radiant light and heat, as

well as actinic rays, is bactericidal and stimulates the healing process.

CANCER.

Notwithstanding all the research work that has been devoted to the etiology of cancer, its real fountain head still remains in obscurity.

Our knowledge of the causes of cancer is well summed up by Leo Loeb of the Washington University School of Medicine at St. Louis. Loeb says: "All the factors which in various ways either by chemical or physical means increase the proliferative energy of cells may act as causes of cancer; these conditions are not different from those growth stimuli which lead to regenerative and what might be called correlative growth in normal tissues; added to these factors are in certain cases factors residing within the cells, which make these cells more responsive to outer growth stimuli; thus providing a sensitization which in other cases is furnished by sensitizing substances carried to the cells from other organs. In order to lead to the formation of cancer in many cases several such factors must cooperate. Some of these factors are hereditarily transmitted in a certain graded quantity from generation to generation, while the other factors are variable and extraneous. All these factors have one characteristic in common: They all increase the growth energy of normal tissues either directly or indirectly, the latter by sensitizing the tissues to the action of growth stimuli."

It is more or less probable that the sensitizing substance within the cell not only stimulates normal growth but also causes abnormal proliferation of its own substance and in its cellular mutations some of the sensitizing substance is set free and enters the lymphatic circulation to be deposited in a favorable soil in some remote part of the body.

Treatment.—In the treatment of cancer by the knife it can be readily understood how the sensitizing substance may be set free and enter the circulation during the operation.

I believe that any cancer that can be removed by the knife may be cured provided all sensitized cells are removed, but it is very difficult to know when they are removed.

The advantages presented by electro-coagulation method of removal become at once apparent. All lymph and arterial channels are at once closed to the migratory efforts of the sensitized cancer cells. Even though a few cancer cells escape removal, the excessive heat at the line of operation penetrates the surrounding cells to such a degree as to destroy the proliferating activity of the sensitizing substance without destroying the normal cell, thus minimizing the tendency to recurrence or metastasis.

Electro-coagulation is a term applied to a process of destruction of tissue by an electrothermic method. Dr. Clark says: "This method is peculiarly adapted to the treatment of malignant tissue, including bone, occurring in any part of the oral cavity, comprising the lips, buccal surface, tongue, floor of the mouth, alveolus, hard palate, antrum, tonsils, pharynx, epiglottis, larynx and proximal end of the esophagus which may be destroyed with one electrothermic operation."

It is sometimes advisable to follow this method with x-ray.

The d'Arsonval type of machine and the bipolar method of application are employed.

Operations involving the throat call for a preliminary tracheotomy and possibly ligation of the carotid artery. (For treatment of Epitheliomata, see Chapter XII, page 393.)

CARUNCLE.

Urethral caruncle is a term applied to a bright red growth situated on the posterior lip of the meatus urinarius. The growth varies in size from very small to quite large. It is very painful during micturition and coitus. It occurs frequently in women.

Treatment.—Caruncles yield readily to desiccation.

Technic.—Bring the growth well into view and thoroughly anesthetize with procain; apply the high-frequency current from a needle-point fulguration electrode for sufficient time to dehydrate the tumor; apply a wet

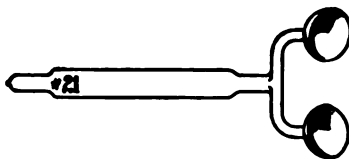


Fig. 87.—Double pole eye vacuum electrode.

boric acid dressing. In this situation owing to the constant moisture of the part, the dehydrated mass soon separates leaving a clean base.

The advantage of this treatment over surgery is that it leaves behind no contracting cicatrix.

CATARACT.

Cataract is an opacity, partial or complete, of the crystalline lens. It may be primary, secondary to disease of other ocular structures or symptomatic of other disorders.

Treatment.—The treatment of cataract is essentially a surgical one, but during the early stage there can be no objection to the application of the galvanic or high-frequency current, with the hope of its absorption or at least retardation. If galvanism be employed, the nega-

tive electrode is applied over a well moistened pad applied to the closed eyelid. There is no objection to wetting the pad with a 1 per cent. solution of potassium iodid; the positive electrode is applied to the cervical region and a current strength of 2 to 4 milliamperes passed for four minutes daily.

Some early cases are benefited by the high-frequency current from a small vacuum electrode applied over the closed eyelid for five minutes daily.

Senile cataract is usually an accompaniment of arteriosclerosis which is best treated by the judicious use of auto-condensation.

CHANCROID.

The treatment of chancroid as employed by Robbins and Seabury, Detroit, is as follows: A small pledget of cotton is wet with a 10 per cent. solution of cocain hydrochlorid and applied to each lesion. After ten minutes this is removed, the field carefully dried, and a 25 per cent. solution of copper sulphate in distilled water applied to each lesion; the high-frequency spark from a fine pointed glass electrode is applied directly to the sore for one to three minutes, depending upon the extent of the ulceration.

In my judgment there is no particular advantage in the delivery of the current through a glass electrode. The effects of the treatment with the copper solution appear to be more effectual than without it.

The treatment of chancroid by copper sulphate alone is well recognized. The results obtained by the combination of copper and high-frequency current cannot be due to copper ionization because a high-frequency current from a vacuum electrode is always negative and from a metal point always alternating. To separate the copper

ions from the solution a direct current is necessary. The effects are probably due to the astringent and antiseptic properties of the copper. The success of the treatment depends upon the thoroughness of the application. Every part of infected tissue must be destroyed, and if this is done, one treatment should suffice. The after treatment consists of a wet boric acid dressing. In case any point of infection escapes destruction it will show within sixty hours when a second desiccation is necessary.

The astringent and antiseptic treatment of chancroid usually requires six weeks to bring about a cure. Under the combined treatment (copper and desiccation) from one to three weeks are required.

CIRRHOSIS OF THE LIVER.

The term "cirrhosis" is applied to many different pathological changes occurring in the liver from localized and general infiltration to extreme fibrosis. For the many classifications, etiology and pathology reference is made to the abundant literature on the subject.

Treatment.—Whatever there may be in the fine points of classification of this disease, the fact remains that when the liver is engorged with excess of blood as it is in the early stage of cirrhosis, the static wave current will give astonishingly favorable results. Place a large electrode over the enlargement, with the patient on an insulated platform; attach the electrode to one pole of the static machine with the other pole grounded, and employ as long a spark gap as may be consistent with the comfort of the patient. In the stage of atrophy, when ascites and more or less edema have occurred, the employment of diathermy will give relief by passing a current of toleration through the liver. It should be used daily for twenty to thirty minutes until results are obtained.

While this does not cure the disease, it is a source of great relief to patients with nutmeg liver, and extends to them a benefit that cannot be realized by any other therapeutic measure.

CHILBLAINS.

For several years past actinic rays has been the usual treatment for chilblains, but Grünbaum has tried the mercury vapor lamp repeatedly in the treatment of this condition without finding it superior to other methods. For the past year he has been trying another method and is enthusiastic over the results. In treating other diseases he discovered accidentally that chilblains improved rapidly following thermopenetration and soon disappeared entirely. He is convinced that this is far superior to all other forms of treatment.

His conclusions agree with others who have employed diathermy for this aggravating condition. Three treatments usually suffice to bring about not only relief but a cure.

Relief of a patient with chilblains may also be obtained by soaking the feet in a saturated solution of common salt and then applying the high-frequency current from a vacuum electrode with a capacity of one inch spark. Treat daily for ten minutes. Two to three treatments will relieve the patient until the next winter.

CHLOROSIS.

Chlorosis is an affection mainly characterized by a reduction of the percentage of hemoglobin and frequently by reduction of the red cells. The predisposing causes are sex, age and constitution. Most cases occur at or closely following puberty. There is generally a congenital tendency toward anemia. It is many times seen when there is a lack of development of the blood-vessels.

Treatment.—As practically all cases of chlorosis present digestive and other disturbances, the treatment is directed to the patient rather than to the disease. In addition to the general hygiene and medicinal treatment much good is often accomplished by the physiotherapeutic measures as suggested for anemia. (See "Anemia.")

CHOLELITHIASIS (Gall Stones).

The term cholelithiasis is applied to that condition which results from the precipitation of cholesterin from bile. Cholesterin and bilirubin-calcium make up nearly the entire mass of biliary calculi. The calculi vary in size and density. The presence of concretions in the biliary passages may produce obstruction of the ducts, ulceration and perforation of the walls. Gall-stones may cause obstructive jaundice, cirrhosis and intestinal obstruction.

Gall-stone disease is not always easy of diagnosis. The conditions from which it is to be differentiated most frequently are pleurisy, neuralgia, gastric colic, intestinal colic, duodenal ulcer and appendicitis.

Treatment.—While we do not wish it to be understood that physical measures alone are to be recommended for this condition, much may be accomplished by their judicious use as an adjunct to other treatment. In the early and formative stage of cholelithiasis much may be done by physical measures as a preventive. The application of radiant light and heat and diathermy will dissipate splanchnic congestion, and it is but natural to apply these measures especially in the early stages of this disease.

I have witnessed the passage of stone through the common duct while the patient was under treatment by radiant light and heat. While a well-developed case of gall-stone is generally considered a surgical case, there

can be no reasonable objection to applying the physical measures mentioned.

CHOREA.

Chorea is probably due to emotional disturbance and endocrine dysfunction. It is often associated with infected tonsils, which intimates that its cause may be of a bacterial nature.

Treatment.—I have never seen a case of Sydenham's chorea benefited by electricity. If there be tonsillar infection associated with choreiform attacks, it goes without saying that it should receive our attention in accordance with the technic suggested under the head of Diseased Tonsils.

CORNEAL ULCER.

Treatment.—The opacities caused by ulcer of the cornea often yield to negative galvanism, 2 to 5 milliamperes for ten minutes every other day.

Ulcers of the cornea result from infection in persons of lowered vitality, consequently general therapeutic and hygienic treatment are indicated.

CONJUNCTIVITIS.

Mild high-frequency current from vacuum electrode applied over the closed eyelid will often clear up a conjunctivitis. It should be used as an adjunct to the usual remedial measures.

DEAFNESS.

Catarrhal deafness is often benefited by high-frequency current from an insulated ear electrode placed within the external auditory canal, with a mild current for five minutes daily (Fig. 88). Hot air vibrations are also useful. In cases where there are adhesions of the

ossicles much may be done with the static wave current applied in the manner suggested by Dr. C. S. Neiswanger.

A binaural electrode so arranged as to fit into both ears is employed. Absorbent cotton is twisted on the ends of the electrode and pointed so as to enter the aural canal. The cotton is then wet with warm water and introduced into the canal. The electrode is then connected to the top of one of the Leyden jars by a suitable conductor. The top of the other jar is grounded. The machine is started with the prime conductors actually touching, and after the machine starts to generate the balls of the prime conductors are carefully separated until the limit of tolerance of the patient is reached. This rarely

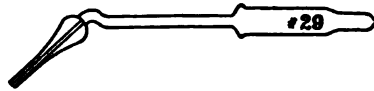


Fig. 88.—Ear vacuum electrode, insulated.

exceeds $\frac{1}{2}$ inch, but generally $\frac{1}{4}$ inch is all the patient will stand. The séance is continued ten minutes and should be repeated daily. This treatment is superior to that usually given by use of the suction pump. The massage given by the static wave current is entirely different as it acts on the muscles and nerves. The rapid oscillations of the static current conveyed to the nerves have a tendency to restore their normal vibration. Dr. Neiswanger cites many cases that have had their hearing restored by this method. (See "Otitis media.")

DERMATITIS VENENATA.

Dermatitis venenata is a term applied to inflammation of the skin produced by external irritating agents derived from the vegetable, mineral and animal kingdoms.

Treatment.—This condition, especially of the ivy poison type, responds well to actinic rays. The rays appear to relieve the burning and limit the spread of the disease.

Technic.—Distance: During the first treatment the lamp should be 3 feet distant; gradually decrease the distance 6 inches with each subsequent treatment to a minimum of 18 inches. Time: Five minutes for the first treatment, increase two and one-half minutes each subsequent exposure to a maximum of fifteen minutes. First 3 treatments should be administered every second day, thereafter twice a week. (See "X-ray dermatitis.")

DIABETES MELLITUS.

True diabetes is characterized by a permanent condition of glycosuria.

The general symptomatology covers those of the nervous and vascular systems, the respiratory tract, digestive apparatus, urinary tract, the skin and locomotor apparatus. When a diabetic comes into our office we are at once confronted with a veritable pathological museum. We at once recognize a faulty metabolism and our efforts are directed to its correction. The treatment of this affection often brings to the mind of the physician a desire for a vacation.

To the dietetic management of this disease we may add diathermy with profit.

Technic.—Place the patient on an auto-condensation couch or pad, place a large electrode over the epigastric region and turn the current on gradually to toleration, then turn the current off slowly, and move the electrode to another location on the abdomen and repeat the maneuver until the entire abdomen has received treatment. Repeat every second day.

This treatment will often cause sugar to disappear from the urine even without change of diet. If hypertension is present, auto-condensation should be employed.

A general application of high-frequency breeze from a multiple-point electrode, to the back and lower limbs is gratefully received by the patient and relieves many of the nervous phenomena which are present in many cases of this disease.

DYSMENORRHEA.

The term dysmenorrhea is often used in a loose manner to signify any or all painful or other disagreeable sensations connected with the function of menstruation.

Dysmenorrhea is a symptom of some pathological condition. It is a symptom of congestion, obstruction, endometrical hypertrophy or it may be due to a neurosis, lack of development of the pelvic organs and many other conditions.

Treatment.—While it is highly desirable to ascertain the true cause of this symptom, the patient may be relieved while she awaits a diagnosis.

There is nothing in the whole domain of medicine that will so promptly and efficiently relieve spasmodic dysmenorrhea as diathermy.

Technic.—Place one electrode over the sacrum and the other over the hypogastrium and gradually turn on the current to toleration of the patient, then gradually reduce the current to zero. One treatment is usually sufficient to relieve the symptom and the physician will have the time to the next menstrual period to make his diagnosis.

Membranous dysmenorrhea is rather rare but when present is easily cured by the softening effects of negative galvanism. The treatment should be instituted im-

mediately after the menstrual period. Technic: An intrauterine electrode having a metal tip $1\frac{1}{4}$ inches long mounted on an insulated staff is attached to the negative pole and introduced into the uterus, with the positive pole on a large well-moistened pad upon the abdomen. The current is turned on gradually until 30 to 40 milliamperes are reached, which is maintained for ten minutes. The treatments are given twice a week until time for the next period. These cases are usually cured within two months.

EARACHE.

The distressing symptoms of many conditions occurring within the ear and known as earache may be relieved while the aurist is arriving at a diagnosis. The diagnosis is essential to the proper management of the case, but the pain may be promptly relieved and the condition often cured by application of radiant light and heat from an ordinary incandescent lamp. In case the application of light and heat does not relieve the pain after 30 minutes, fill the aural canal with a warm isotonic solution of zinc, cover the ear with a pad of gauze soaked in the same solution and again apply the lamp. Watch the pad and lamp to see that the dressing does not become hot enough to cause a burn. I never have seen a case of earache from any cause outside of foreign bodies and disease of the brain that would not yield to this treatment.

ECLAMPSIA.

Eclampsia is a condition characterized by convulsive seizures that come on suddenly prior to, during or after labor. The obstetrician of today witnesses few cases of eclampsia because he has been trained in the condition that produces it. He systematically examines the urine not alone for albumen but casts and urea, the quantity

passed in twenty-four hours, as well as nitrogen retention of the blood. He is on the alert guarding against surprise and danger.

Treatment.—The treatment of eclampsia may be considered as prophylactic, medicinal and surgical. From an electrotherapeutic standpoint only the prophylactic will be considered.

One of the earliest and most constant signs of a toxic condition is a gradual increase in the systolic blood pressure and will often be noted a month or more before albumen can be detected in the urine. If the systolic pressure reaches 145 in a pregnant woman otherwise normal, look out for eclampsia. Take the pressure as early as possible in your obstetric cases and as often as every two weeks during the period of gestation. When the pressure is found to be gradually increasing do not wait for albumen to appear but give the patient the benefit of all doubts by the application of auto-condensation at such intervals as may be necessary to keep the systolic pressure close to normal. Even after the appearance of albumen in the urine and edema about the ankles, auto-condensation will bring about an elimination of toxins in a more satisfactory manner than by any other method.

ECZEMA.

Eczema may be either an acute, subacute or chronic inflammatory disease of the skin, characterized by the appearance of erythema, papules, vesicles or pustules or a combination of any two or more of these lesions. It is attended with a variable degree of thickening and infiltration of the cutaneous tissues, terminating either in discharge with formation of crusts or in absorption or desquamation.

There are several varieties of the disease for a complete description of which you are referred to standard works on diseases of the skin.

The symptomatology is characteristic. The etiological factors are constitutional and the attacks precipitated by mechanical or chemical irritation. It is quite probable that some member of the family of staphylococcus or streptococcus is a prominent factor in the causation of the disease. Eczema associated with asthma or hay fever is usually anaphylactic.

Treatment.—The treatment of this disease has been as varied as the index to the pharmacopeia, but since the advent of röntgenotherapy its management has been easier. Not every case of eczema is cured by the x-rays, but a large percentage of them are symptomatically cured by fractional doses of the rays. Relief from the intense itching is prompt and satisfactory.

Actinic rays while not preventing recurrence, has proved an active therapeutic agent and an almost instantaneous specific for the pruritus. In acute cases the initial treatments should be very mild with the same technic as described under dermatitis.

Where the disease is marked by thickenings and infiltrations the close application of the Kromayer lamp may prove essential.

It ought not to be necessary to state that indicated medicinal and hygienic measures should be employed along with the physical ones mentioned.

In all cases of eczema which do not yield to treatment, it is advisable to administer the protein sensitization test. While the test does not prove absolutely that the particular protein is the cause of the disease, it is a suggestion that it may be a factor when a removal from the diet is advisable. The test is made as follows: A slight scarifica-

tion of the skin of the flexor surface of the forearm is made, not deep enough to draw blood, but sufficient to penetrate the skin. On the cut is placed the suspected protein, to which is added a drop of one tenth normal sodium hydroxid solution to dissolve the protein and permit its absorption. At the end of one-half hour the protein is washed off and the reaction noted. Always compare with normal control. A positive reaction consists of a raised, white elevation or urticarial wheel.

EMPHYSEMA.

For treatment of this condition, see "Asthma."

EMPYEMA.

While the treatment of thoracic empyema is surgical, the postoperative management by the physical measures mentioned under treatment of bronchiectasis will hasten recovery.

ENDOMETRITIS.

Endometritis is an inflammation or hyperplasia of the uterine mucous membrane, involving to a greater or less extent the parenchyma of the uterus. It may exist in the acute or chronic form. The acute form may be so mild as to be overlooked and the chronic form supervene in a gradual manner. Patients with endometritis are apt to complain of general nervous symptoms rather than local, hence they are often regarded as neurotic; but a careful examination will reveal the true condition. It is quite probable that the nimble gonococcus plays an important rôle in the etiology of the disease.

The pronounced tenderness of the endometrium upon touch of the sound is characteristic of painful endometritis. A differential diagnosis between endocervicitis and corporeal endometritis, carcinoma and sarcoma should be made before treatment is instituted.

Treatment.—The acute form resulting from suppressed menstruation, excessive coitus, overexertion or blows upon the abdomen is promptly relieved by diathermy of the pelvis.

I am partial to the ions of copper in chronic endometritis. With the positive pole of pure copper within the uterus and the negative electrode of large size and well moistened, on the abdomen or under the sacrum, and a direct current of 30 to 70 milliamperes for twenty minutes, results more or less marvelous will be secured. The tip of the electrode should for obvious reasons be insulated. The current should be turned on gradually to the height of tolerance, and if the abdominal electrode be of proper construction and properly applied there will be no difficulty experienced from a current strength of 70 milliamperes. The treatments are given from four to seven days apart. If light currents (25 to 30 milliamperes) are used, the interval between treatments may be as short as four days. When heavier currents are employed a longer interval is advised. If the septic condition does not clear up in 6 or 8 treatments the more penetrating ions of zinc may be used with advantage.

If upon attempting to remove the electrode from the uterus after ionization it is found to be adherent, a gentle rotary pull will usually be sufficient to remove it with the inflammatory products adhering thereto. In case the electrode adheres too strongly to be removed by gentle traction, a reversal of the current will loosen it sufficiently to be withdrawn. A perfect insulation of the vaginal portion of the electrode must be secured before the current is turned on.

EPIDIDYMITIS.

Gonorrheal epididymitis is satisfactorily treated by the static wave current. The positive electrode is applied

directly over the epididymis and held in place by the patient's hand. A current which is well tolerated by the patient is employed. This treatment encourages drainage through the natural channels.

EYE-STRAIN.

Absolute relief may be expected from negative galvanism applied over the closed eyelids for a period of ten minutes.

EPILEPSY.

Very little has been accomplished in this disease by the various electrical modalities. If the blood-pressure be high auto-condensation is indicated. Every case of epilepsy has poor elimination and all the benefit derived from electricity is due to its power to effect elimination. We must look to our *Materia Medica* for palliations for this disease.

The x-ray has been the means through which we have been able to find, in nearly all cases of epilepsy, an interference with the development of the pituitary gland. The inter-pituitary area in a large percentage of cases will be found narrowed causing dysfunction of the gland. This would suggest the administration of pituitary substance.

ERYSIPELAS.

Erysipelas is a violent inflammation of the lymph channels caused by the entrance of the *Streptococcus erysipelatis*.

The most frequent site is about the face and head. The constitutional symptoms correspond to the intensity and extent of the local process. There may be a wound where the infection occurs, but often there is no cutaneous evidence of the seat of the infection.

Treatment.—The multiplicity of remedies advocated for the treatment of erysipelas is the best evidence that no specific exists. The best treatment, however, for this condition is the luminous rays from an incandescent lamp. The rays are bactericidal and the hyperemia produced increases phagocytosis which makes the treatment almost specific.

Actinic rays will destroy the streptococcus.

In using the incandescent lamp for erysipelas do not lose sight of the fact that prolonged exposures are necessary. One hour exposures four times a day will secure satisfactory results.

If you think local applications of anything should be used do not look for anything better than a saturated solution of epsom salts.

FAVUS.

Favus is also known as "honeycomb ringworm." It is a parasitic skin-disease due to the presence of a vegetable parasite which, growing in the epidermis, hair and nails, causes varying grades of inflammation, alterations of structure, and, when occurring upon hairy parts, partial or complete loss of hair.

It is characterized by the presence of sulphur-yellow cup-shaped crusts having a peculiar odor and which, on microscopic examination, are found to be composed of the elements of fungus.

Treatment.—Radiotherapy is a sure cure for this disagreeable affliction.

Technic.—By the Kienbock-Adamson method the hair is clipped close to the scalp. Divide the scalp into five areas and administer an epilating dose (H 1; spark gap 9 inches) to each area at one sitting. The face, ears, neck and back are shielded. The largest skin-distance must always be the

same and each treatment at right angles to every other treatment.

The scalp is marked out in the following manner: A mark is made in the middle line, 1 inch inside the anterior hair line. A similar mark is made 1 inch inside the posterior hair line. These marks should be exactly 10 inches apart; if not, they are so adjusted that the required distance is obtained. Then a mark is made exactly in the center of this line. Two more marks are made about 1 inch above and a trifle forward of the external auditory meatus. These marks are so adjusted that they are exactly 5 inches from every other mark.

The hair will fall out in three weeks and begin to grow again in from one to three months. Fractional treatment will accomplish the same result provided a total of H 1 is administered in three weeks.

FIBROIDS.

The treatment of the interstitial variety of uterine fibroids by röntgenotherapy is usually a satisfactory one. The advantages over surgery are: no loss of time; no hospital fees; no phlebitis; no ill effects if properly administered.

Fibroids do not degenerate into malignancy neither does x-ray produce adhesions. Röntgenotherapy is signally successful in nearly all cases of uterine bleeding, but it is possible for the first radiation to increase it.

Menorrhagia and metrorrhagia are frequently caused by excessive production of graafian follicles, and their destruction is easily accomplished by intensive x-ray treatment. This procedure in young women, however, should be undertaken with caution and never without a thorough understanding by the patient that the treatment will probably

cause sterility. In women approaching the menopause the treatment is ideal.

Technic.—The rays should be directed through the tumor from four or more points of entry, one point a day for four successive days, with an interval of three weeks between the séances. The dose should be intensive (3H to 6H), 9 inch spark gap with at least 5 mm. of aluminum filter. Radiation of the ovaries may be avoided by proper protection. Time required, six to nine months.

Small fibroids may often be made innocuous by the direct current. A suitable electrode for this purpose has been devised by Neiswanger. It consists of a hollow metallic staff insulated with hard rubber. To its distal end is attached a hollow copper ball about 1 inch in diameter and perforated in a number of places to allow the escape of fluids. To the proximal end is soldered a receptacle for the cord tip. The electrode is about 10 inches long. The ball is covered with cotton over which is placed gold beaters skin and tied firmly with a thread. With the aid of a proper syringe the electrode is kept full of a weak solution of adrenalin. The electrode is passed well up into the *cul de sac* and is attached to the positive pole. The negative pad should be of large size (kaolin pads are best), and placed on the abdomen.

Of whatever material it is composed the negative pad should be so constructed as to allow of the passage of heavy currents without distress to the patient. The current strength in this treatment should not be less than 60 milliamperes. My experience teaches that a current strength of 75 milliamperes in the majority of cases is the correct one.

A solid vaginal ball electrode, amalgamated with mercury and well covered with cotton well saturated with a solution of adrenalin or even water may be used, but the Neiswanger electrode is less liable to cause a burn. The

intra-uterine treatment with a bare copper electrode is sometimes difficult on account of the tortuous canal and consequently has given way to the vaginal application.

FISTULAS AND FISSURES.

The treatment of fistulous tracts by zinc ionization is as a rule more satisfactory than by surgery. Not unlike surgery, the ionization method must reach every part of pyogenic membrane and destroy it. The resulting cicatrix from ionization is not so extensive as that caused by the knife and is more readily absorbed.

The technic is simple: It is advisable for the operator to fashion his own electrode from a sheet of zinc (Ionization Electrodes Nos. 5 and 6), which is easily and quickly done. The strip of zinc may be passed through a piece of glass or rubber tubing, the ends being secured by sealing wax. The size and shape of the electrode are best when made to conform to the size and length of the fistulous tract.

It may sometimes be necessary to anesthetize the part to be treated. Choose the proper shaped electrode; connect with the positive pole of the battery and insert the electrode to the bottom of the tract. The negative pad may be placed at some indifferent point. Turn on a sufficient amount of current for the purpose, say 5 to 20 milliamperes, depending upon the size of the electrode. An ionization for ten minutes is usually sufficient. If all parts of the tract are reached by the zinc one treatment will suffice; if not, the treatment may be repeated in four days.

Where one is not quite sure of reaching all the pyogenic membrane with the electrode, the treatment as suggested under Abscess is advised.

Copper electrodes may be used instead of zinc, but the results are not quite so satisfactory.

FRACTURES.

When to a surgeon the suggestion is made that the time in healing fractures may be shortened one-third to one-half, better results obtained and many deformities obviated by the timely employment of electrotherapeutic measures, he will quite likely inquire the name of the institution from which you escaped.

No splint was ever applied to a limb that did not impede the circulation and consequently lower its vitality.

Atrophied muscles, adherent tendon sheaths and ankylosed joints result from improper after-management of fractures and dislocations. Proper adjustment of the fragments of fractured bone may be made and the proper splint applied and still the result be anything but desirable.

The too common practice of allowing splints to remain from one to four weeks without removal is to be condemned. There are a few fractures, Pott's may be named as one, from which it is inadvisable to remove the splint before sufficient callus is formed to retain the fragments in position under careful manipulation, but in nearly all cases the splint should be removed not later than the third day and at least twice a week thereafter, and diathermy applied for the purpose of maintaining proper nutrition.

Mild contraction of the muscles should be induced by static or sinusoidal currents. The current from a Bristow coil if properly controlled will do as well. Diathermy will hasten the formation of callus by increasing the metabolism of the part thus shortening the time of disability. If the muscular activity be maintained by proper exercise the muscles will be able to do their part as soon as sufficient union of bone has taken place.

Every surgeon's office and hospital should be equipped with proper electrical modalities which should be employed

by competent doctors or nurses and an end put to the disabilities resulting from careless or neglected treatment.

FURUNCULOSIS.

The treatment of furuncles or boils has been considered under the head of "Abscess."

GANGRENE.

Gangrene of the foot or limb due to endarteritis obliterans is often arrested by reflected incandescent light. The pain is relieved where morphine fails. Endarteritis is often regarded as Raynaud's disease. Diathermy is also efficient in these cases. About 75 per cent. of cases are cured by these methods, others requiring amputation.

GOUT.

Gout is a condition of faulty metabolism and is benefited by auto-condensation. Keep away from affected joints with vacuum tube applications until the acute symptoms subside, after which such applications will hasten the absorption of exudates. Even auto-condensation will sometimes aggravate an acute case. Radiant light and heat may be employed in any stage and will greatly hasten resolution.

GLAUCOMA.

The essential characteristic of this disease is increased intraocular pressure.

Symptoms.—The eyeball is more resistant to pressure than when normal. A very early symptom is the appearance of colored rings around distant lights at night. However, these halos may be absent in glaucoma. The anterior chamber is shallow and finally becomes obliterated. The pupil is usually dilated and finally becomes fixed. Pain may be intermittent but is usually constant and is often

referred to the brow, cheek or temple. The field of vision is narrowed. Glaucoma is due to constitutional conditions and is usually associated with hypertension.

Treatment.—The first indication is to correct the constitutional condition. Hypertension is promptly reduced by auto-condensation. The contracted arteries may be dilated allowing the excessive secretion within the eyeball to escape by application of the high-frequency current through the eyelids by a vacuum electrode.

Some cases are benefited by negative galvanism. Apply a current of toleration for ten minutes and follow by pneumo-massage and vibration of the 3d cervical vertebra. After the patient becomes blind electricity in any form will fail.

GOITER

The term goiter simply means an enlargement of the thyroid gland. Goiters are divided according to their pathology into parenchymatous, cystic, adenomatous, fibrous, malignant and exophthalmic. On account of the rarity of the fibrous and malignant forms they will be omitted from this discussion.

The etiology and pathology of diseased thyroids, also, will be left for you to glean from the voluminous literature on this subject.

The four principal varieties of goiter will be considered because each variety calls for a different method of treatment.

Parenchymatous goiter is the most common form and consists of a general hypertrophy of the entire gland. It usually comes on about the time of puberty and is of slow growth. The tumor is bilateral, the normal shape of the gland being preserved. It may attain an enormous size without causing any symptoms of impaired health.

Cystic goiter is one where one or more cysts causes the enlargement and there are no particular symptoms other than those of pressure.

Adenomatous goiter is one where an adenoma is the cause of the enlargement. It is often difficult to distinguish from the parenchymatous form, but it is usually unilateral and is quite likely to be of rapid growth. It is more apt to cause dyspnea than the parenchymatous form.

Exophthalmic goiter rarely occurs before puberty or after middle life. The prominent features of this form are: Exophthalmos, tachycardia, enlargement of the thyroid which is often pulsatile, tremulousness of the hands and general nervous excitability and sometimes a pigmentation of the skin resembling Addison's disease. In a well developed case the diagnosis is very easy, but there is a time in its early stages when it is very difficult to differentiate from the parenchymatous form, and this is very important from a therapeutical standpoint.

Dr. Henry R. Harrower has given us a method of testing the function of the thyroid gland, the technic of which is very simple and, if followed, will prevent many errors in therapeutics.

There are two distinct classes of patients with thyroid disease. One is known as the *hypos*, meaning those who have an insufficiency of thyroid secretion, which is more common in the parenchymatous form where the gland enlarges in order to be able to furnish the body with the proper amount of hormone; the other, the *hypers*, meaning those who have increased thyroid secretion which produces a metabolism far in excess of the needs of the body, resulting in a toxemia which produces the usual classical symptoms of exophthalmic goiter. It is many times difficult to determine to which class a certain case of exophthalmic goiter belongs, hence, the Harrower test is an important one.

The *hypos* will be benefited by the administration of thyroid.

The *hypers* will be made worse by thyroid.

The Harrower Test.—The patient is directed to take the pulse at 3, 6 and 9 o'clock and make a record on a pulse chart. The next day or first day of treatment the patient takes one-half grain of thyroid at 8, 10, 12 and 2 o'clock, recording the pulse at 9, 12, 3, 6 and 9 o'clock on the pulse chart. On the second day the patient takes one grain of thyroid at same hours and records the pulse as before. On the third day the patient takes 2 grains of thyroid at the same hours and records the pulse as before. On the fourth day the pulse is recorded in the same manner, but no thyroid is taken. On the fifth day the pulse is recorded at 9, 12, 3 and 6 o'clock. The chart is then returned to the physician. If at any time during the treatment nervous irritability occurs, the treatment ceases and the patient reports to the physician, but the pulse record is still kept for the five days. These pulse charts will be very interesting, and at the end of the five days you will be able to classify your cases into *hypos* and *hypers*.

In every case of goiter we should investigate the entire body for foci of infection and if possible eliminate them before or at the same time we are treating the effects of hypo- or hyper- tension. While electrotherapeutic methods will cure a large majority of goiters, do not be disappointed when they fail.

About 25 per cent. of goiters are primarily surgical, which leaves 75 per cent. for the electrotherapist who should get positive results in 80 per cent. This leaves about 15 per cent. of failures, which is much less than the surgical failures.

The most promising cases of goiter for electrotherapy are those of decided symptoms without or with but little

exophthalmos. We will fail in practically all cases of adenomatous goiter, and we will fail in *every* case of cystic goiter, while we will fail in most cases of simple or parenchymatous goiter. Practically all of the varieties just mentioned should be classed as surgical.

It is often difficult to determine whether or not a certain case is surgical. Under such circumstances we should try electrotherapy for a period of four weeks. If we do not secure an amelioration of symptoms in that length of time the case should be turned over to the surgeon.

Every case of exophthalmic goiter should receive electrotherapeutic treatment prior to an operation.

Treatment.—Electrotherapists recommend four distinct modalities for the treatment of goiter, *viz.*: Static, galvanic, high-frequency and x-ray.

I have had experience in almost every form of electrotherapeutical application ever suggested as being useful in the treatment of goiter, greatest experience having been with the galvanic current and x-ray. I have secured positive results in many cases by galvanism before high-frequency currents were thought of. I have also cured many cases with static currents used in conjunction with x-ray. I have had signal success with a combination of high-frequency currents with x-ray.

We should not attempt to treat cystic goiter, as it is always a surgical case.

We may be able to decrease the size of an adenomatous goiter by x-ray, but it is also a case for the surgeon.

Parenchymatous or simple goiter may be treated by diathermy, by galvanism, by a combined treatment of static and x-ray or by a combination of high-frequency current from a vacuum electrode with x-ray.

In exophthalmic goiter the objects to be attained by treatment are: (1) Reduction of size and activity of the

gland; (2) relief of the tachycardia; (3) alleviation of nervous excitability; (4) improvement of general nutrition; (5) removal of infection.

Relief of tachycardia, alleviation of nervous excitability and a general improvement of nutrition may be obtained by high-frequency currents from a vacuum electrode applied over the cervical sympathetic ganglia and the gland itself, but relapses are common. I would never think of applying diathermy to a case of hyperthyroidism. It is, however, sometimes useful in hypothyroidism. Some operators may have secured results in hypos and been led into making extraordinary statements about the management of goiters in general.

The procedure which I usually follow is: First examine the patient for foci of infection. These may be found in the sinuses communicating with the nasal cavity, the tonsils or the pelvis. Wherever found their removal is of first consideration. Then test the function of the thyroid by the Harrower method. If we secure an improvement in the symptoms, or no effect whatever by the test, high-frequency vacuum applications to the cervical sympathetic for five minutes, with a finishing up application to the gland itself for two minutes is the method employed.

In case thyroid aggravates the symptoms the first treatment consists of a crossfiring with the x-ray. This crossfiring of the Röntgen ray reduces the thyroid secretions, produces an endarteritis of the thyroid vessels, which lessens its blood supply, in consequence of which the gland reduces in size. The first treatment by x-ray may cause an increase of toxemia, therefore, it should be a light one, about one-third of an erythema dose. After two weeks the second treatment is given with a spark gap of 8 inches—8 inch focal distance; filter of 3 mm. of aluminum, allowing sufficient time for two-thirds of an erythema dose. The appli-

cation should be made over three different areas, right, left and anterior. The same technic should be followed three weeks after the second treatment. From two to three months should elapse before repeating the treatment. Three such séances are usually sufficient for the abatement of symptoms except the exophthalmos. The toxic symptoms are usually improved after the first séance. It is possible to overtreat these cases and cause a hypothyroidism, which should be avoided.

I know of no condition treated by x-ray that requires as great skill as that of goiter and no one without a thorough knowledge of its pathology should undertake röntgenotherapy of the thyroid. A surgeon brings into his court all competent witnesses and carefully weighs the evidence before he operates. No one has a moral right to treat a goiter by x-ray until he has made a painstaking investigation and proved to his satisfaction that it is the best method of procedure for the case in hand. When the decision is made to apply röntgen treatment, be sure to do it thoroughly.

The first favorable signs following the treatment are: Reduction of pulse rate and gain in weight. Watch the toxic symptoms rather than the size of the gland. Reduction in the size of the gland usually, though not always coincides with the amelioration of symptoms of hyperthyroidism. It is best to discontinue treatment before all symptoms of goiter disappear. Do not overlook the fact that hyperthyroidism is a result of dysfunction not only of the thyroid but other ductless glands.

In some cases of goiter, usually the large soft variety, the galvanic current gives best results. A large negative pad should be applied in front, completely covering the goiter, with the positive pole pad on the patient's back; pass 70 to 80 milliamperes for thirty minutes daily for three days

with intervals of three days rest. In order to be able to use these heavy currents, a kaolin pad may be necessary. Sometimes iodine in the form of a 2 per cent. solution of iodide of potassium applied on the negative pad gives better results. Almost every case of adolescent goiter may be cured by 15 milliamperes current applied in the manner just stated.

Sometimes after x-ray treatment, tremors, tachycardia and nerve exhaustion still persist. For this condition full doses of hypodermic ergot in conjunction with static wave over the cervical region is an admirable treatment.

Hypodermic ergot is prepared as follows: Alcoholic extract of ergot, 1 dram; chloretone, 3 grains; distilled water, 1 ounce. Filter; Dose, 30 to 60 drops, hypodermically.

Strict attention to diet should be paid to every case of Graves's disease. The menus should consist of milk, fruits, green vegetables, cereals with little or no meats and very little if any tea or coffee.

HAY FEVER.

Several observers have reported favorable results in hay fever by the use of the high-frequency current delivered from properly shaped vacuum electrodes.

Dr. Wm. G. Lewi, Albany, New York, has done considerable work along this line with varied results. My experience with this as well as other forms of electrical treatment has not been satisfactory.

I have had no experience with ultra-violet rays in this affection, but favorable results have been reported on the use of this agent by means of a quartz rod applicator to the affected membrane.

HEMORRHOIDS.

A hemorrhoid is defined as a vascular tumor of the mucous membrane of the rectum, the skin or both. There are two varieties of hemorrhoids: The internal and the external. They are called internal when situated internal to the sphincter and covered with mucous membrane, and external when they are situated outside the sphincter and involve the skin. The symptoms are usually characteristic but should be differentiated from polypi, villous tumors, malignant growths and prolapsus.

Treatment.—In the management of cases of hemorrhoids we should always take into consideration the condition of the patient. He is usually overfed and constipated, consequently more or less toxic. The liver does not functionate properly and there is considerable obstruction to the portal circulation. Toxins enter the circulation and usually cause an elevation of blood-pressure. However, we may find an occasional case with relaxation and hypotension.

In the treatment of hemorrhoids we should always generalize the disease and individualize the patient. The vicious habits of the patient should first enlist our consideration. Toxins must be removed, and, in this connection auto-condensation stands first among our implements of first aid.

The first treatment by auto-condensation should be limited to 400 milliamperes for ten minutes and the treatment be followed by a dose of castor oil. I know of no better treatment for unloading the portal circulation than the application of the static wave current to the liver—a large pad over the liver and with a spark gap as long as the patient will tolerate, usually 5 to 8 inches.

Next in order of usefulness in relieving engorgement of the liver is diathermy. Diathermatize the liver for

twenty minutes 3 times a week with a current strength of 1000 to 2000 milliamperes if possible within the toleration of the patient. Sometimes a less milliamperage is more effectual. Clean out the food tube and keep it as clean as possible. In this connection the application of the sinusoidal current to the abdominal contents will be found to be of signal benefit. Vibration of the dorsal nerves will also be useful.

This line of treatment will cure practically all cases of recent development. However, if there be chronic thickening or dilatation of the venous walls, I know of no surgical procedure that equals the Clark method of desiccation, the technic of which is as follows:

A preliminary purgative and enema are given. The area about the anus is anesthetized with a solution of procain which is sufficient to allow of dilatation of the sphincter for operation on internal piles. If the pile is external a local injection into base of pile will be sufficient for desiccation. If internal, the tumor is pulled down and clamped and desiccated down to the clamp and cut away with scissors. A soothing suppository for several days after the operation is advisable. The advantages over all other methods are: It requires only one treatment; it does not require a general anesthetic; there is no danger from a secondary hemorrhage; there is less inflammatory reaction than when cautery is employed; strictures are avoided and small tumors may be removed in the office and the patient go about his business.

This treatment is seldom followed by scar tissue. If, however, through extensive operation infiltrated tissue be feared, this may be obviated by the use of the high-frequency vacuum rectal electrode charged with the static wave current. Do not deceive yourself in thinking this to be a high-frequency current. It is an unidirectional pulsatory cur-

rent and promptly drains the tissues and prevents induration.

HERPES ZOSTER (Shingles).

Herpes zoster is an acute inflammatory disease of the skin, appearing along the course of certain cutaneous nerves and is characterized by the occurrence of groups of tense papules arising from a swollen base.

The outbreak of the eruption is preceded by severe pain in the neighborhood of the area to be attacked, but sometimes it occurs at some distant point. The eruption may occur on almost any part of the body, but its favorite site is along the course of intercostal nerves and about the scalp and face. The surface lesions are due to an inflammation of the nerves supplying the affected area. The skin lesions are entirely secondary to the neuritis.

Treatment.—The unpleasant symptoms caused by the eruption are often relieved by high-frequency application through a vacuum electrode. The diseased nerves should be treated by the same technic as for neuritis.

It is said that much relief from the neuralgic pains may be afforded by a general body application of actinic rays. The local application of the rays to the eruption is said to greatly reduce its duration.

Technic.—Lamp 3 feet distant; time of exposure, three minutes, gradually increased to a maximum of twelve minutes in 4 treatments. Treatments are given every other day.

HYPERIDROSIS.

Hyperidrosis is a condition characterized by excessive sweating of the palms or soles.

Treatment.—When this condition is not relieved by ordinary remedies a perfect cure may be had by radiotherapy.

Technic.—Treatment by the fractional method is to be preferred. A dose of $H\frac{1}{4}$ to $H\frac{1}{2}$ every day for three days is usually sufficient. Overtreatment should be avoided as it will make the skin harsh and dry. When applying to the palms the fingers should be so flexed as to receive an equal dose with the palm.

HYSTERIA.

The treatment of hysteria is essentially the same as for neurasthenia.

HYPERTRICHOSIS.

Hypertrichosis is that condition in which the hairs of the body are increased in number or size or grow in unusual situations, or in normal situations in unusual length or number.

Treatment.—Superfluous hairs are easily removed by negative electrolysis in the following manner: Let the patient hold the well-moistened positive electrode in the hand. A bulbous pointed needle is inserted into the hair follicle at the side of the hair for about $\frac{1}{8}$ of an inch; a current strength of from $\frac{1}{2}$ to 1 milliampere is turned on; as soon as a bubble of gas appears the hair will loosen and can be easily removed. The treatment is followed by an inflammatory reaction so it is advisable not to remove too many hairs from the same area at a sitting.

INCONTINENCE URINÆ.

Incontinence of urine in the female may be treated by vibration of the lumbar vertebræ, percutaneous application of faradism or the sinusoidal current; 1 pole over the sacrum and the other over the hypogastrium, or 1 pole in the urethra with opposite pole on the abdomen.

My experience with electricity in these cases is not very flattering. Some cases are relieved, but in the majority the

relief is but temporary. I have better success with $\frac{1}{2}$ to 1 ampoule of pituitrin every four days.

INFECTIONS.

Superficial types of infection are successfully treated by radiant light and heat. When applied to the entire body radiant light and heat will stimulate the lymphocytes and lymphoid tissue and the effect will persist for several days. The heat from this agent produces an increased resistance to infection to a degree capable of overcoming the germ process. It has been proved by experiment that the lymphocytosis produced by this agent affords immunity to transplanted cancer.

To be successful with radiant light and heat in cases of superficial infection, it is necessary to make long exposures. From 2 to 4 exposures of one hour each should be made daily.

This comparatively new treatment for infection is a great improvement over all old lines of therapy. The röntgen ray will also promptly sterilize small infected areas.

INSOMNIA.

Find the cause if possible and remove it. Positive static breeze for twenty minutes will often be attended by relief, especially if the cause be of a psychic nature.

As these cases are usually toxic, the auto-condensation treatment is indicated to facilitate elimination.

INFANTILE PARALYSIS (Poliomyelitis).

Poliomyelitis is a myelitis of the anterior horns of the spinal cord which results in a paralysis of the flaccid type, occurring usually in children. The paralysis is rapidly followed by muscular atrophy.

Treatment.—While the static wave current is indicated in the early stages of this disease, I have found it very difficult of application to young children. The application is painless, but most children are frightened by the appearance of the paraphernalia and will not assume that quietude so necessary to success. The nutrition of the affected muscles must be kept up and nothing will do this quite so well as diathermy and the sinusoidal current.

IRITIS.

Chronic iritis often yields to radiant light and heat combined with galvanism when other measures fail.

The light should be applied for fifteen to thirty minutes over the closed lids and followed by negative galvanism, 2 to 4 milliamperes for ten minutes every day for three days then every other day. Of course the constitutional condition should be treated in accordance with its etiology.

KNEE-JOINT INJURIES.

Semilunar cartilage injuries are of two kinds, one in which the ligamentous connections between the tibia and the face of the cartilage is torn away and the cartilage becomes loose and permits a catching in the joint at times, but there is seldom any locking of the joint. Associated with this condition are pain, lameness and effusion. The other in which the internal edge of the cartilage is caught and fractured.

Treatment.—The prevailing treatment has been entirely surgical, but many cases are better treated by physiotherapeutic methods.

Dislocated semilunar cartilage of the knee joint should be reduced and the resulting synovitis treated by the static wave current and vibration. Diathermy and high-frequency treatments are useful. Some cases call for aspiration which

should be followed by static wave and sparks. Frauenthal treats these cases by injections of 10 per cent. tincture of iodine directly into the cartilage which may be located $1\frac{1}{2}$ inches internal to the inner border of the patella. This causes an acute inflammation which fixes the cartilage. The treatment may have to be repeated 3 or 4 times.

These pains may be relieved by ionization of a 2 per cent. solution of sodium salicylate or potassium iodide.

LEUKEMIA

Leukemia is a disease characterized by an increase of lymphatic tissue in the body and by an excess of white corpuscles in the blood. The symptoms are varied but characteristic. Very white or dull yellow skin, petechiae, accidental ecchymoses and areas of pigmentation, pruritus and gastric troubles are common. Hemorrhages from mucous membranes and into the skin are frequent. A careful examination of the blood will complete the diagnosis. Not only the quantity but the quality of the leucocytes is changed.

Treatment.—Electroionization is indicated for its assistance in chemotherapy. It also has a tendency to increase the proportion of red cells. The therapy of the long bones to increase the hemoglobin and the nitrogen ray to the spleen to lessen leucocytosis.

LEUKEM

There are many varieties of leukem, but in this connection only the variety called purpura will be considered.

This disease is an essential inflammation of the skin with an eruption consisting of papules that are broad and tend to be flat, flat and raised at the top and slightly white with red of a purplish-red color. The lesion favors the hairy surfaces of the forearm, the flanks around the umbilicus and calves. The disease is more or less severe.

Treatment.—The pruritus is promptly relieved by x-ray. A cure is usually obtained by fractional or semi-intensive treatment. Time required, one to two months.

LUMBAGO.

Uncomplicated lumbago is a myalgia of the lumbar muscles. It has been called muscular rheumatism, but I have serious doubts of its connection even remotely with rheumatism.

Pain in the lumbar region may be the result of any one of several pathological lesions, but when due to local muscular spasm there is nothing that will relieve the condition quite so well and quickly as sparks from the static machine. Radiant light and heat is useful; it should be applied for at least one hour. High-frequency from a vacuum or non-vacuum electrode will promptly relieve many cases. Hot air vibration is also useful.

My treatment for lumbago is about as follows: Apply radiant light and heat from a 1500 watt lamp to the lumbar region for one hour and follow with ten minutes application of static wave or sparks from a non-vacuum electrode. It is sometimes well to apply a high-frequency or static spray from a multiple-point electrode just far enough away to avoid sparks. This treatment is very gratefully received by the patient.

LUPUS.

Lupus vulgaris is a chronic disease of the skin and sometimes of the mucous membranes and is characterized by nodules of granulated connective tissue. It finally terminates in ulceration or atrophy with scar formation. The causative factor is the tubercle bacillus.

Treatment.—In the early stage when there are but few small nodules they may be destroyed by desiccation. Some

has been successful in x-ray therapy but in my hands this method has not been an entire success.

The method of zinc ionization is a tedious method, but it has been successful. The technic of zinc ionization is as follows: The nodule is first treated to denude it of resistant tissue. The treatment consists of zinc ions. The liquor zinc is made by taking a piece of lint soaked in isotonic solution of zinc sulphate. The positive electrode is placed on the nodule and the negative over a large wet pad may be placed on the back. The negative electrode should be a piece of zinc the size of the positive and should be placed under at least 16 layers of lint, and should be changed frequently. There should be no contact between the electrodes.

The current strength should be as strong as the patient can stand and should be continued for thirty minutes. The treatment is repeated every three or four days. The nodule becomes a crust which should be allowed to fall. This treatment should be continued for two weeks at a time. In case the patient is unable to stand the inflammatory reaction, the treatment should be continued for one week. In case the patient is unable to stand the treatment, it may be repeated in three or four days.

The patient should be kept in a room with intense radiation for the entire day.

Procedure.—Using a 2000 volt, 1000000 röntgen each capsule is a minimum of 10 röntgen. The treatment is continued for three or four days. The treatment is continued for three or four days.

METHODS OF TREATMENT

The patient should be kept in a room with intense radiation for the entire day. The treatment is continued for three or four days.

technic is explained under the heads of Endometritis and Fibroids.

MYALGIA.

The treatment outlined for lumbago is applicable to myalgia.

MIGRAINE.

Cases of migraine are born, not made. The patients are always toxic. A course of auto-condensation consisting of 5 daily treatments and 1 treatment every two weeks thereafter will do much for these patients toward warding off attacks.

While these chapters are not intended to be discourses on drug therapy, I hope I may be pardoned for mentioning a few good things, and one of those good things for an attack of migraine is potassium bromid, 30 grains with 15 grains of sodium salicylate, preferably in seltzer water. It must be given when the headache is approaching.

MYCOSIS.

Any disease of the skin characterized by soft mammillated tumors or fungoid neoplasms.

Treatment.—The ideal treatment for all fungous growths on the skin is radiotherapy. While mycosis fungoides is seldom cured, an occasional treatment will keep the patient comfortable.

Technic.—The dose at first should be small fractional $H\frac{1}{8}$ to $H\frac{1}{4}$. Later on the dose may be increased to $H\frac{1}{2}$. The disease may be kept under control by close watching and application of x-rays when needed.

MENOPAUSE.

The nervous phenomena occurring at this time in a woman's life are wonderfully relieved by an occasional treatment by auto-condensation.

MASTOIDITIS.

An infection of the mastoid cells. Do not be tempted to use electricity; its treatment is purely surgical.

MOLES.

All warts, moles and benign growths should be removed. Not every mole will take on cancer proliferation but it is their tendency to do so, and when their removal is attended by little or no pain nor inconvenience it becomes the duty of every physician to recommend to his patient the early removal of these growths.

Treatment.—There are two methods of promptly and efficiently removing moles and skin blemishes. First: Desiccation will remove an ordinary mole in ten seconds. This may be done by the direct method by a fulguration electrode. Place the needle about $\frac{1}{4}$ inch from the mole and turn on a mild unipolar high-frequency current; allow the short sparks to play until the color of the mole changes to the color of charmois skin. Allow crust to form which will fall in ten to twenty days leaving a clean healthy skin. The indirect method is by seating the patient on the auto-condensation chair and connecting opposite side of machine to ground. The operator may hold a needle in his fingers with which he touches the mole.

The second method is by electrolysis. A small needle is attached to the negative pole of a continuous current and introduced into the mole, parallel to the skin. The needle should penetrate almost through the growth. The positive pole may be at any indifferent point. Turn on a current of 2 to 4 milliamperes for sufficient time to blanch the growth. Allow crust to form and fall.

While I used this method for many years, after the advent of high-frequency currents I have employed the

desiccation method which is more easily and quickly applied and causes no more pain to the patient.

NEURALGIA.

Superficial neuralgias are often relieved by ionization of a 2 per cent. solution of sodium salicylate, quinine bisulphate or cocaine hydrochlorid.

Neuralgia of the sciatic nerve or brachial plexus may be relieved by a dose of H3 of x-ray. For brachial neuralgia the rays should be directed to the 4th, 5th, 6th and 7th cervical vertebræ; for sciatica, over the sciatic notch. Vibration of the cervical vertebræ is also useful in brachial neuralgia.

Galvanism is also useful in neuralgias: Positive pole over the painful area and negative at some indifferent point. The dose should always be given within the toleration of the patient. If about the head and face, 2 to 5 milliamperes is about the amount the patient will tolerate.

Some cases will respond to exposure of actinic rays.

NEURASTHENIA.

This is a condition which taxes the resources of the physician and undermines the sanity of his patient. All degrees of nervous manifestation from hyperexcitability on the one hand to depressive melancholia on the other are present.

The term neurasthenia serves to designate many forms of neuroses as well as psychoneuroses. In neuroses proper the disturbances which manifest themselves in physical and mental actions are nearly always of a toxic character, but may be due to repressed sexual function.

Civilization means nothing more than suppression of animal instincts, and morality in these days is generally

understood to be the suppression of the sexual instinct which consists of a combination of many factors.

The causative factor of neuroses proper or neurasthenia may be found under one of the following heads.

1. Toxemia.
2. Syphilis.
3. Suppressed or perverted sexual function.
4. Americanitis.

In psychoneuroses hereditary taint may be added to the above causes.

In a few instances the cause of the patient's condition may be ascertained from his story, but often he will deliberately try to deceive the physician. If the patient's confidence in his physician is once gained and the interest of the physician sufficiently aroused the etiological factor may and probably will be discovered.

A neurasthenic will always exaggerate, but to reject his story of suffering is to open the door to failure. While he exaggerates, suffering to him is a reality. Do not lose sight of the fact that his nervous system is on a strike, temporarily embarrassed or possibly bankrupt. In the majority of cases, however, the causative factor is so deeply covered by multiplicity of symptoms that its discovery is one of the most difficult problems in medicine. A patient should never be told that his troubles are imaginary. It may be true that his imagination is working over time, but there is always a beginning, a magneto as it were, to initiate his modified conception of tangible things.

Thousands of men and women are abiding in sanitariums and asylums conveyed there by authority of our courts and who might have been in happy homes of their own if the spark which caused the conflagration could have been discovered. When the physician chooses his profession he incurs a debt to mankind and in discharge of this obliga-

tion he is in duty bound not only to endeavor to save his patient but protect the public as well. There is no greater blot on the escutcheon of medicine than that of neglect of the neurasthenic.

We as physicians may be not blamed for what we do not know, but every patient is entitled to the best there is in us and none more than the victim of neurasthenia.

There is no definite nor distinct symptomatology *per se* of the condition we are pleased to term neurasthenia unless it be that of a combination of all the unpleasant sensations derived from any or all the varied pathological conditions to which man is heir.

It is more or less common for a physician who is unable to make a diagnosis of some pathological condition to jolly himself by a mental reservation that his patient is a neurasthenic, prescribe a combination of antispasmodics and sedatives and allow the spark to become a blaze through want of recognition of the underlying cause of the patient's obsession.

Not all neurasthenics are constipated but it is well to remember that intestinal stasis plays an important rôle in the etiology of neurasthenia. Whatever may be the theory of autointoxication, it is axiomatic that a large per cent., if not all cases are toxic. The offending toxin may come from without but usually comes from within the body. There may or may not be a focus of infection.

The statement that every case of neurasthenia has its origin in toxemia is not easily proven but it is the belief of the writer, based upon experience, that every case is caused or accompanied by this condition.

In nearly all cases of neurasthenia there exists a dysfunction of the endocrine glands, supra-renal inefficiency being the most common. On theoretical grounds the ad-

NEURASTHENIA

NEURASTHENIA IS A SYNDROME OF NEURAL ORIGIN IN WHICH THE PATIENT IS

CHARACTERIZED BY A GENERAL WEAKNESS OF NERVOUS SYSTEM AND A TENDENCY TO A HIGH SENSIBILITY TO THE INFLUENCE OF STRESS. IT IS A WELL DEVELOPED AND

IS A SYNDROME OF NEURAL ORIGIN IN WHICH THE PATIENT IS CHARACTERIZED BY A GENERAL WEAKNESS OF NERVOUS SYSTEM AND A TENDENCY TO A HIGH SENSIBILITY TO THE INFLUENCE OF STRESS.

THE SYMPTOMS OF NEURASTHENIA ARE OF TWO KINDS. FIRST, THERE IS A GENERAL WEAKNESS OF THE NERVOUS SYSTEM AND A TENDENCY TO A HIGH SENSIBILITY TO THE INFLUENCE OF STRESS. SECOND, THERE IS A TENDENCY TO A HIGH SENSIBILITY TO THE INFLUENCE OF STRESS.

THE SYMPTOMS OF NEURASTHENIA ARE A VERY COMPLICATED ONE. THERE ARE TWO KINDS OF SYMPTOMS AND THEY ARE OF TWO KINDS. FIRST, THERE IS A GENERAL WEAKNESS OF THE NERVOUS SYSTEM AND A TENDENCY TO A HIGH SENSIBILITY TO THE INFLUENCE OF STRESS. SECOND, THERE IS A TENDENCY TO A HIGH SENSIBILITY TO THE INFLUENCE OF STRESS. WITH ALL THE KNOWLEDGE AND IN OUR TREATMENT WE SHOULD BE ABLE TO REMOVE THE CAUSAL FACTOR OF THIS SYNDROME MORE EASILY THAN HERETOFORE. BUT WITH ALL THE ASSISTANCE OF MODERN METHODS OF DIAGNOSIS THE TREATMENT OF NEURASTHENIA IS MORE OF A SYMPTOMATIC ONE. THE MANAGEMENT OF THIS CONDITION IS RAPIDLY BECOMING EASIER AS WE ADVANCE IN OUR KNOWLEDGE OF THE APPLICATION OF PHYSICAL MEASURES IN THERAPEUTICS.

AFTER THE CONFIDENCE OF THE PATIENT IN THE PHYSICIAN HAS BEEN GAINED THE WAY TO SUCCESS IS WELL PAVED. VERY SELDOM DOES THE TREATMENT OF NEURASTHENIA PRESCRIBED IN THE PAST. THE TREATMENT OF NEURASTHENIA IS TO BE IT BE THE ACQUISITION OF A HIGH SENSIBILITY TO THE INFLUENCE OF STRESS. THROUGH THE APPLICATION OF PHYSICAL MEASURES OF ERGOT, AND THE TREATMENT OF NEURASTHENIA IS TO BE IT BE THE ACQUISITION OF A HIGH SENSIBILITY TO THE INFLUENCE OF STRESS.

It is to be assumed that the mode of living, diet, habits, etc., have been investigated and so near as possible a protein free diet prescribed after which the most important thing to do is to clear the alimentary tract, this being best accomplished by castor oil for which "something just as good" does not exist as there is *no* substitute. The cleanliness of the food tube should be maintained and all foci of infection eradicated. In 70 or more per cent. of cases in the male the focus of infection will be found in the prostate, seminal vesicles or deep urethra; in a large per cent. of cases in the female the focus of infection will be found within the pelvis. Posture and dress greatly influence the splanchnic circulation and must be corrected. Vicious habits must be overcome. A relaxed condition of the abdominal muscles is present in nearly all cases. Nearly if not all the organs of the abdomen are in a state of ptosis. Too much blood is found in the splanchnic area. In other words the body is being continually bled into the great splanchnic lake. The liver is flooded and unable to properly prepare the existing toxins for removal. Whether this condition be the cause or the result of the nervous insolvency it should be corrected. The abdominal muscles should be toned up by the systematic application of the sinusoidal current and the liver unloaded by the static wave or diathermy. A current strength of 800 to 1200 milliamperes should be passed through the liver for fifteen or twenty minutes daily until the desired result is obtained. The dysfunction of the nerves supplying the affected area should be corrected by vibration. Neurasthenia is usually associated with hypotension and is often the only objective sign of the disease. The Abrams method of concussion of the spines of the 6th and 7th dorsal vertebræ is very effective in raising blood-pressure. A few cases are accompanied with hypertension

which when present may be easily corrected by auto-condensation.

By the application of physical measures we are relieving a very much greater proportion of these cases than was possible before the adoption of this method of therapy. There is no question that this line of therapy will save thousands from ending their days in psychopathic institutions and asylums.

NEURITIS.

Neuritis is an inflammation of a nerve. It is usually confined to the nerve coverings, hence should be called a perineuritis. It may effect the connective tissue sheath of the nerve. It may extend from the periphery to the spinal cord or brain. It presents all degrees of severity from very mild (myalgic pains) to the severe when degeneration of nerve takes place.

Multiple neuritis is characterized by a simultaneous inflammation of several nerve trunks, usually on both sides of the body. This form is due to a chronic poisoning from alcohol, arsenic, mercury, lead or malaria. It sometimes follows infectious diseases such as diphtheria and typhoid.

Neuritis is always due to pressure either from without or within the nerve sheath. When from within it is due to infection or poison, and when from without it is due to mechanical pressure from tumors, dislocations and the like or chemical activities.

Treatment.—The successful management of neuritis lies, first, in a perfect diagnosis; second, in removal of the cause; third, in application of physical measures to relieve the condition.

Ordinarily the practitioner of today treats all cases of neuritis with rest to the affected parts, medication to cover up the symptoms, such as aspirin, acetanilid and opium. If

your object in view is to make a dope fiend, I know of no shorter route than that of prescribing opium to one affected with neuritis. If you desire to make a chronic case out of an acute one, put the patient in bed and prescribe acetanilid. If you don't know anything else to do give him aspirin. There are cases of neuritis of such severity as to require a sedative such as phenacetine, but the great majority can be relieved without sedative drugs. Rest may in a few cases be indicated for a day or two, but be cautious lest rest cause your acute case to become chronic.

The treatment *par excellence* is heat by diathermy. Apply it twice daily for thirty minutes. Direct the patient to apply radiant heat and light from an incandescent lamp during the intervals of treatment by diathermy. This treatment is applicable at any stage of the disease. In acute cases the static brush discharge or an aura from a high-frequency multiple-point electrode may be of service in relieving the pain. In the chronic stage static wave current alternated with diathermy will be of service to remove infiltrations and exudates. If the cause is discovered early and removed, diathermy will cure every case before it has had time to become chronic.

Not only is diabetic neuritis benefited by electrification, but a favorable impression is made upon the disease itself. I have seen sugar disappear from the urine under electrical treatment when no attention whatever was paid to the diet.

I have had signal success in brachial neuritis with the galvanic current with positive to the cervical region and negative to arm or forearm, 10 to 20 milliamperes for twenty minutes daily. I always expose the patient to radiant light and heat during the treatment by galvanism.

OTITIS MEDIA.

Otitis media is an inflammation of the middle ear and caused by infection. It may occur with or without fever; with or without earache.

Treatment.—The medical treatment is about as follows: If the ear drum seems but slightly red the nose is bombarded with a mixture of menthol, camphor and petrolatum or a solution of argyrol with the idea of contracting the mucous membrane about the eustachian tube, thereby promoting drainage. In case the drum is red to its entire extent or bulging, or there is tenderness over the mastoid, the drum is punctured that drainage may be promoted.

The physiotherapist treats these cases early by radiant light and heat which prevents extension to the mastoid.

In cases of suppuration of the middle ear with an opening through the drum without infection of the mastoid, zinc ionization is the ideal treatment. If the zinc solution reaches all suppurating surfaces one treatment will stop the suppurating process.

Technic.—An electrode for this purpose may be constructed easily from a horn or hard rubber ear speculum, a coil of wire and a pledget of cotton (Ear Ionization Electrode No. 7). Wrap a small coil of wire with cotton allowing a sufficient amount of the cotton to protrude through the speculum so as to reach the ear drum; place the cotton-covered wire within the speculum and place the speculum in the ear with protruding twist of cotton touching the drum. Attach the wire of the speculum to the positive pole of a direct current; fill the speculum with warm isotonic zinc solution and keep it full during the treatment, with the patient on his side and the indifferent or negative electrode on his side underneath. Allow a current of 5 to 8 milliamperes to flow for seven to ten minutes. I have cured many chronic ear discharges by this method.

PARALYSIS (Local Palsies).

Jaw.—In paralysis of the jaw, the motor branch of the trigeminus is paralyzed. There is inability to chew because the temporal and masseter muscles are unable to contract. The jaw cannot be closed tightly, opened strongly nor moved laterally. The jaw reflex is abolished. Trigeminal lesions are usually unilateral. The salivary secretion and taste are affected when the proximal or distal end, but not the middle of the nerve is affected.

Face.—In facial paralysis or Bell's palsy, the muscles of expression of one side of the face are paralyzed. There is difficulty in closing the eye. The forehead cannot be wrinkled. When attempts are made to close the eyelids (Bell's phenomenon) the eyeball turns outward, the cornea disappearing behind the upper lid. The angle of the mouth cannot be raised, the lips cannot be firmly closed and mastication is difficult. In severe cases the paralyzed muscles exhibit the electrical reaction of degeneration. In early stages the face is drawn toward the healthy side; later on the face may be drawn back again permanently, due to the newly formed connective tissue in the degenerated muscles.

Treatment.—The antiquated idea that electricity must not be employed in facial paralysis, or other palsies for that matter, should be relegated to the junk heap of misconceived notions. Modern therapy of palsies is based on common sense in that a relief of the congested area should be had at the earliest possible moment, and this indication is met in the application of diathermy and static wave currents. Atrophic conditions may be prevented by the proper application of these currents. After atrophy has commenced the muscles should be treated by galvano-sinusoidal currents, of a mild nature. A strong current causes fatigue and the very object sought is nullified. Fibrillation of mus-

cles may be produced by fatigue as well as by nerve degeneration. Again the interrupted galvanic current is too abrupt and shocks the nerve; the faradic current is too sharp and causes a too sudden impulse; the sinusoidal with its gentle rise and fall promotes nutrition, its action comes nearer to the normal than that of any other current. If this current is preceded by a warming up process from radiant light and heat or diathermy the effects are increased. The sinusoidal waves should never exceed 50 per minute and a slower one is advisable. Facial paralysis is often relieved by x-rays directed over the mastoid.

Neck.—In paralysis of the neck the spinal accessory nerve is affected. When the trapezoid muscle is affected the shoulder sinks down and forward, the arm is raised with great difficulty, if bilateral the head tends to fall forward. When the sternocleidomastoid muscle is paralyzed the head is drawn toward the shoulder with the chin turned upward and toward the affected side. When this muscle is paralyzed on both sides the head tends to fall forward.

Treatment.—Percussion of the 1st, 2d and 3d cervical vertebræ should be carefully done for one minute twice or thrice daily. Positive galvanism to the upper cervical region is indicated but should be preceded by a warming up process. Slow sinusoidal to restore muscular nutrition should follow the treatment just mentioned. The sinusoidal may be given for five minutes twice daily.

Tongue.—When the tongue is paralyzed and an attempt is made to protrude it, it turns toward the paralyzed side. When this condition exists there is a paralysis of the hypoglossus nerve. The cause will be found in some intracranial lesion not necessarily luetic.

Treatment.—There is little to be done with electricity, but much may be done by constitutional remedies. I have

seen a clinical cure effected by a prolonged course of mercury.

Arm.—When the supra- and infra-spinatus muscles are paralyzed outward rotation and abduction of the arm are impaired. The ulnar side of the hand is turned forward. This condition also exists in paralysis of the supra-scapular nerve. When the long thoracic is paralyzed the serratus anticus major is affected so that when the scapula is raised, its lower angle approaches the vertebræ and the inner margin of the scapula does not lie close to the thorax and upon movements of the arm upward and forward, stands from the thorax like a wing. When the anterior and posterior thoracic are paralyzed the inward and forward movement of the arm is impaired; the hand cannot be placed on the opposite shoulder. In sub-scapular paralysis the motion of the arm backward is impaired. In axillary paralysis the deltoid and teres minor are paralyzed so that the arm cannot be raised.

Lesions of the brachial plexus (Erb's palsy) cause paralysis of the deltoid, biceps, brachialis anticus and spinators long and short. In some cases the supra- and infra-spinatus muscles are also paralyzed, and to a less extent the extensors of the wrist and fingers. Anesthesia of the outer aspect of the forearm and hand is occasionally present. Lesions of the 5th and 6th cervical nerve roots are usually the cause of this condition.

Treatment.—The pain of brachial lesions may be relieved by a dose of H3 x-ray which should be applied over the 5th and 6th cervical vertebræ. Percussion or vibration of the same vertebræ is indicated. The early application of radiant light and heat or diathermy and static wave will relieve the congestion and possibly, atrophy averted. If atrophy has already commenced the muscles should be

treated by galvano-sinusoidal currents of a mild nature, just enough to cause a visible response.

Hand.—In median paralysis the pronators and flexors of the hand and fingers, also muscles of the ball of the thumb are paralyzed. The thumb cannot be brought across the hand to touch the little finger. The first phalanges of the fingers can be flexed but not the 2d and 3d phalanges.

In ulnar paralysis the interossei, the 3d and 4th lumbricals and the muscles of the little finger are paralyzed. The fingers cannot be spread. When atrophy has occurred "claw hand" results.

In Musculo-spiral and radial paralysis the extensors and supinators of the hand and fingers and the abductor pollicis longus are paralyzed. The thumb is adducted. Wrist drop is present. Wrist and fingers cannot be completely extended.

Treatment.—The treatment should be radiant light and heat followed by chlorin ionization to the lesion indicated. Galvano-sinusoidal and static wave to prevent atrophy. Mild faradism from a Bristow coil may be used with benefit. Be careful not to overtreat as the muscles are easily exhausted.

Leg.—In crural paralysis flexion of the thigh on the body and extension of leg on the thigh are difficult or impossible; jumping is impossible and standing and walking are difficult. If the obturator nerve is affected adduction of the leg, crossing the legs, and pressing the thighs together are impossible. If the gluteal muscles are paralyzed abduction and rotation of the thigh are impossible. There is generally much muscular atrophy.

In sciatic paralysis the foot and toes are affected; the leg cannot be flexed on thigh and rotation of the thigh is impaired. There is usually foot drop and a high stepping gait.

Treatment.—The first indication is a dose of H3 x-ray directed to the sciatic notch; radiant light and heat to relieve congestion followed at the proper time by galvanosinusoidal and mild Bristow coil currents.

In ischemic paralysis of the hand or foot, place the part in a solution of salt and attach one metal electrode to the wrist or ankle, the other in the solution and continue a current of toleration for twenty to thirty minutes daily.

Nerve Injuries.—Electric response following nerve injuries is very important from the standpoint of prognosis. Conductivity is conclusive evidence of physiological continuity of nerve fibers.

An immediate improvement in the conductive excitability after neurolysis suggests some degree of nerve block, but indicates a future recovery. Notwithstanding the loss of conductive response after a neurolysis which indicates a severe nerve injury, it does not signify complete severance of nerve, nor preclude recovery.

The first indication of nerve recovery is a change from a slow to a quick response to a galvanic current. This occurs some time before voluntary motion or response to the faradic current, and indicates some degree of recovery has already taken place. The change from slow to quick response may be entirely overlooked unless eagerly sought for.

PARALYSIS AGITANS.

Paralysis agitans is an incurable disease, but static insulation and diathermy are useful in relieving extreme agitation.

PNEUMONIA.

Dr. Osler has said, "Pneumonia is a self limited disease and runs its course uninfluenced in any way by medicine." He also has said, "It can neither be aborted nor

cut short by any known means at our command." His statement about the influence of medicine upon the course of pneumonia may be correct, but it is very evident that he never tried diathermy or he would not have made the assertion that there were no known means at our command that would cut short the disease.

During the first stage of pneumonia the congestion can be dissipated by diathermy, and the second and third stages can be most favorably influenced by its application.

Technic.—In case of one lung involvement, place large electrodes anteriorly and posteriorly. In double pneumonia place the electrodes latterly; in any case, bring the involved tissue between the electrodes. A chair pad may be slipped underneath the patient as the posterior electrode. Begin with small amperage and, in the stage of engorgement gradually raise it to 1700 or 2000 milliamperes (if it be possible to reach the point within the toleration of the patient) and continue its application for twenty to thirty minutes and repeat every six hours. In the stage of hepatization a lower milliamperage should be used, reaching 1400 milliamperes at the close of the treatment. Twenty minutes will be sufficient. Repeat every six hours.

The effects of diathermy are: diminution of dyspnea, cough, cyanosis, pain and nervousness. The pulse becomes softer and slower, the respirations slower and deeper, the expectoration loses its tenacity. After the first application the patient often falls into a quiet and peaceful sleep.

In pneumonia as well as all other cases where diathermy is employed, the bowels should be kept open by castor oil or salines. Plenty of water, hot or cold as preferred by the patient, should be given. Diet during the first twenty-four hours should be low; after the second day the diet may be modified according to circumstances. You don't need digitalis or strychnine. If any drug be indicated in the early

stage of pneumonia it is hypodermic ergot. It acts as a stabilizer of the vaso-motor mechanism and will sometimes abort the disease especially the influenza type. If for any reason diathermy cannot be used the ergot treatment should by all means be used.

PLEURISY.

The best treatment for pleuritis is diathermy with the same technic as in pneumonia.

My experience with actinic rays has not been extensive enough to form an opinion of their value in either pleuritis or pneumonia, but treatment by the rays by others has been quite satisfactory.

Technic.—Distance from the lamp 24 inches; time of exposure, first treatment, three to five minutes, according to the susceptibility of the patient's skin, increasing one to two minutes each radiation. The treatment is given daily.

PROSTATITIS.

Through all the ages since the animal man began to walk on his hind legs he has been afflicted with diseases of the prostate gland. It is estimated that 60 per cent. of all men who have attained the age of 60 years possess abnormal prostates. I have treated over 800 cases of diseased prostates with the static wave current with 60 per cent. favorable results. There is not a therapeutic measure known to the profession that will so effectually clear the seminal vesicles and prostate of gonorrheal infection as the static wave current properly applied. The technic is as follows: Place the patient on an insulated platform, insert in the rectum an L-shaped copper rectal electrode resting against the prostate. The patient is seated preferably on a hard bottom chair; the stem of the electrode resting on the chair bottom assists in holding the electrode against

the gland. Connect the electrode with the positive prime conductor of the static machine, the negative being grounded to a steam, water or gas pipe. Start the machine with the ends of the discharging rods close together, with the Leyden jars in the circuit; gradually widen the spark-gap until the point of comfortable tolerance is reached. Time of treatment fifteen to twenty minutes. The best work will be done with the spark-gap so arranged as to obtain 100 to 200 pulsations per minute. Very rapid pulsations will relieve pain, but to secure drainage slow pulsations are required. In a large percentage of cases of prostatitis caused by the gonococcus, urethral stricture exists as a complication. Urethral stricture should be treated by electrolysis. Cystitis is present in many cases and when present should be treated by bladder irrigations. The administration of hexamethylamin is advisable unless found too irritating. Other medicinal measures may be indicated.

Dr. Neiswanger treats this disease by positive galvanism. He has devised for the purpose an electrode consisting of a soft rubber rectal tube 15 inches long and having a caliber of 32 F., has the distal end perforated with small holes for a distance of $2\frac{3}{4}$ inches. The tube is fitted its entire length with a spiral wire composed of galvanized iron. To the proximal end of this spiral wire is permanently attached a metal fitting for the tube of any ordinary fountain syringe, and to this is soldered a receptacle for the conducting cord from the battery. To the perforated end of the tube a bag made of kid is firmly tied so as to include all of the perforations within the bag. In the fountain syringe is placed about a quart of normal salt solution at a temperature of 125° F., and the syringe placed at an elevation of about 6 feet. Place the patient in the Simm's position with the usual wet pad on the abdomen attached to the negative of a continuous current. After having

thoroughly wet the skin bag inside and out, force out all the water through the perforations, lubricate well and introduce into the rectum to cover the prostate. Connect electrode to the syringe and allow the hot water to fill the kid bag (be careful not to over-fill; it should be only $\frac{2}{3}$ full as it fits to prostate better than when full). Now connect electrode with the positive pole of battery and turn on a current of 30 to 40 milliamperes and allow the current to flow for ten minutes and repeat the treatment three times a week.

In acute prostatitis much may be done toward relief of the patient by the high-frequency current from a prostatic vacuum electrode applied to the prostate. Do not allow the electrode to remain to exceed seven minutes as it is liable to burn the mucous membrane. If it is thought best to use diathermy it may be done by the same electrode in contact with the prostate connected to one pole with the opposite pole on the hypogastrium, employing a current strength within toleration of the patient. The time of treatment should not exceed seven minutes as the prostatic electrode is liable to stick to and burn the rectal mucous membrane.

PRURITUS.

Pruritus ani is usually permanently relieved by the ionization of iodine or zinc.

Technic.—Form an electrode of a piece of zinc or block tin about $2\frac{1}{2}$ inches in diameter in such a manner as to fit between the nates and place on a thick pad of felt or gauze which is well wetted with an isotonic solution of zinc sulphate, place the pad in position and connect the electrode with the positive pole of a galvanic battery. The negative which should consist of a large well moistened pad can be placed under the patient's buttock as he lies

in the Simm's position and connected to the opposite pole of the battery. Turn on the current gradually until a comfortable warmth is felt by the patient and continue the treatment for twenty minutes. This may be repeated at two or three-day intervals until cured. From 2 to 5 treatments are usually sufficient. During the treatment no ointments are to be used. The parts must be kept clean by a washing with soap and water after every evacuation. In case there is great thickening of the membrane and it does not yield promptly to the zinc ionization, the treatment should be changed to Lugol's solution, but remember when using iodine in this manner it must be placed on the negative pole otherwise the technic is the same.

There are very few cases of pruritus of the crotch, anus and scrotum that do not yield to actinic rays.

Technic.—Distance of lamp, 30 inches for first treatment, decreasing the distance 1 or 2 inches each subsequent treatment until a minimum distance of 18 inches has been reached. Time, first treatment, five minutes, increasing by two minutes each subsequent treatment until a maximum of eighteen minutes has been reached. Repeat every other day.

PSORIASIS.

The U. S. Army X-Ray Manual states that any type of psoriasis yields promptly, as a rule, to the x-ray.

Technic.—Widely separated patches are to be shielded closely and treated individually; fractional or semi-intensively. Generalized eruption necessitates treatment of most of the body surface including normal skin between the lesions. Divide the body into sections as follows: (1) Scalp, face and neck. (2) Chest, abdomen. (3) Dorsal back, lumbar back, buttocks. (4) Thighs (four surfaces). (5) Legs and feet (two surfaces). (6) Arms, forearms,

hands (two surfaces). To avoid overlapping, mark dividing lines with a skin pencil. Expose one section daily with fractional dose of $H\frac{1}{8}$. No one section is to receive treatment in one week. After the second week if improvement is not satisfactory increase to $H\frac{1}{4}$. If the disease is not under control in four to six weeks discontinue the treatment. When the lesions have disappeared stop treatment—do not treat the remaining stains. X-ray cures the lesions not the disease.

It is said that actinic rays will cause a disappearance of the lesions, but they will recur.

PYOSALPINX.

Do not fuss with electricity. This condition calls for the services of a surgeon.

PYORRHEA ALVEOLARIS.

Mild cases of pyorrhea sometimes yield to high-frequency current applied by means of a properly shaped vacuum electrode.

Zinc ionization is also useful, but your patients will be better pleased with the service of a good dentist.

PTOSIS.

Concerning ptosis of the eyelids, Dr. Samuel J. Harris says: "Iodine ionization alternated every other day with the sinusoidal current is efficacious." Dr. Harris has devised an electrode for treating affections of the eye by ionization. It consists of 2 eye cups fastened by screws to a metal bar shaped with a curved center to fit the nose, and made adjustable. The bar is fastened to a wooden handle through which a connecting rod is passed, with a screw arrangement at the end of handle for the wire. He uses Morse pads for the indifferent electrode. The Morse pad

ELECTROTHERAPY.

is covered with asbestos and crash, is
10 to 12 inches long and 3 to 4
inches wide.

RESCINATISM

...the word in the English
...patients who have vague
...and many doctors who
...corroborate their state-
...other salicylate and

I have seen a few cases of rheumatism as a disease. I have seen dozens of cases of rheumatism in that time. I do not see the disease as a form of rheumatism, but I can see the disease as a form of rheumatism. I have seen a case during a long time. I have seen rheumatism does not exist. I have seen a case of rheumatism.

The resulting picture of the rheumatism condition is described in the next page. It shows that the patient's condition is such that the credit of the patient and the credit of the physician are both at stake. The patient's condition is such that the credit of the patient and the credit of the physician are both at stake. The patient's condition is such that the credit of the patient and the credit of the physician are both at stake.

Electromagnetism is caused to interfere. The particular mechanism has not been isolated but is supposed to be of the electromagnetic family. The interference ~~does not seem~~ to be for its field of activity and may arise from some ~~other~~ source long for any beneficial effect from electricity in any form during the stage of infection and as a matter of fact any electric current will aggravate the disease. The ~~formation of~~ clots and adhesions, even those of the endocardium may be dissipated by proper application of the static electric current and diathermy. We may confidently expect

to remove by auto-condensation the resulting toxemia or rheumatic infection.

RHEUMATOID ARTHRITIS.

Rheumatoid arthritis (*Arthritis deformans*), which, by the way, is an arthritis, but bears no relation whatever to rheumatism. This disease if recognized early enough may be prevented by the same measures that prevent cardio-renal diseases. After anatomical changes have occurred the disease is incurable, but much may be done by auto-condensation and diathermy to give comfort to the patient and prevent further changes. (See "Arthritis.")

RHINITIS.

True hypertrophic rhinitis when treated by adrenalin, copper or zinc ionization makes a rapid course to recovery.

Technic.—An efficient electrode may be made in one minute by doubling a copper wire on itself and wrapping the same with cotton. Wet the cotton with a solution of adrenalin and place against the membrane to be treated: attach the electrode to the positive pole of the continuous current. The negative pad should be placed on back of the neck. Allow 2 to 5 milliamperes of current to flow for five minutes. The treatment may be repeated every other day. By this method we secure the astringent effects of the adrenalin and the antiseptic and astringent effects of the copper. An electrode made of zinc will answer the same purpose.

SACRO-ILIAC TROUBLE.

Sacro-iliac troubles which may or may not receive the designation of subluxations are accompanied by pain and tenderness over the joint, the pain extending down the course of the sciatic nerve. There is usually a list of the body to one side. Flexing the thigh upon the abdomen,

with the knee extended, causes pain in the joint. With the patient's back to the observer, standing alternately on the right and the left foot and with the other knee flexed to chest; when the thigh passes the horizontal if a sharp pain producing click be heard, the diagnosis of sacro-iliac subluxation may be made. With knee extended and leg flexed to 80°, if a radiograph be taken it will show a separation at the lower border of symphysis and some separation at the lower end of the sacro-iliac joint.

Treatment.—Careful vibration of the joint gives great relief when accompanied with proper support. Before applying electric currents be sure that the joint is not tuberculous. If it be tuberculous any form of electricity will aggravate the condition. In such cases fixation, rest and x-rays are the proper essentials of treatment. If pus has formed it should be evacuated before it forms tortuous sinuses. Do not overlook the fact that the cause of sacro-iliac dysfunction may be luetic, strepto-, staphylo- or gono- coccic.

If the condition is one of subluxation, the joint should be supported by a bandage, corset or supporter to hold the ilium in place. Long applications (1 to 2 hours) of radiant light and heat followed by static sparks to relieve spasm of gluteal and other heavy muscles is the best procedure in these cases. Ionization of a 2 per cent. solution of aconite is often useful. Normal muscular contraction must be restored in order to hold joint in place. Exercise, with the body in opisthotonus position, up and down several times (two or three times a day) will greatly assist the return of muscular tone.

SCARS.

The normal process of healing by second intention is a transformation of granulation into fibrous or cicatricial tissue. Sometimes a distinct fibrous growth occurs and is then known as keloid.

Destruction of skin is always followed by formation of scar tissue. In a very large proportion of cases scar tissue is of minor importance, but when it results in stricture of mucous passages and cavities, stiff joints, indurations about nerves, adherent tendons and other fibrosities it becomes a question of major importance.

Scar tissue is poorly organized, is susceptible to degenerative changes and is predisposed to malignancy.

Treatment.—In the treatment of cicatricial tissue we have nature's remedies—light, heat, water and electricity with its chemical, thermic and mechanical effects. In radiant light we have the effects of all the rays of the visible spectrum. Beyond the violet of the visible spectrum we have the short ultra-violet rays. Beyond the ultra-violet we have still shorter rays which are more penetrating and are known as x-rays. Beyond the x-rays we have the still shorter rays of radium known as gamma rays.

For superficial heat we have all kinds of hot applications. In water we have the whirlpool bath and other hydrotherapeutic measures.

In electricity we have the direct continuous current for softening effects of ionization; the high-frequency current for thermopenetration; the faradic and sinusoidal current for mechanical effects; the static current for sedative, stimulating and mechanical effects; x-ray and radium for their resolvent and regenerating effects.

Scar tissue may be removed by first heating the part with radiant light and heat or diathermy followed by ionization of a 2 per cent. solution of sodium chloride, sodium salicylate or sodium iodide. Several layers of lint soaked in the solution are applied to the surface to be treated and over this pad is placed a metal electrode which is attached to the negative pole of a constant current. Treatment should be continued from twenty minutes to one hour. The current

strength should be 3 milliamperes to each square inch of electrode surface or as strong as the patient will tolerate. The treatments should be given daily until results are obtained. The number of treatments required will be found to be in proportion to the density of the tissue and the time the scar has existed.

Ionization should be followed by massage or vibration. Adherent scars are amenable to x-rays. Only partial results are to be expected when the scar is adherent to bone. Recent scar tissue about nerves causing neuritis is readily absorbed by a few exposures to röntgen rays. Painful thickenings beneath the surface resulting from tenotomies yield rapidly to x-rays.

The benefits derived in these cases are due to the selective action of the x-rays on poorly organized tissue.

Technic.—Employ a hard tube capable of a 6 inch back up spark with 2 milliamperes current for five minutes at 12 inch target-skin-distance. In superficial cases employ a filter of 1 mm. of aluminum; in deep cases use 2 mm. aluminum filter. This dose may be given on alternate days. Three to 6 exposures are usually sufficient.

In fibrous ankyloses the first indication is heat. Apply diathermy until the joint is thoroughly heated and follow this by the static wave current or static sparks and close the treatment with passive exercise. The sinusoidal or Bristow coil current may be employed for their mechanical effects on the muscles of the neighborhood.

SCIATICA.

The causes of sciatica are many and varied, but like neuritis elsewhere, it is always caused by pressure from within or without the nerve. With one exception, sciatica, like brachial neuritis, causes no limitation of passive mo-

tion, whereas arthritis of the hip joint interferes with some movement or other.

The following test will differentiate arthritis from sciatica: With the patient supine on a level surface and the pelvis perfectly level, the thigh is flexed and then the ankle is placed above the patella of the opposite extended leg. The knee is now depressed. If there be arthritis of the hip the patient will complain of pain before the knee reaches the level of the opposite knee. This position is easily attained in cases of sciatica.

In case of sciatica, with the knee well flexed, the thigh can be fully flexed without pain; but when, with the thigh thus flexed an attempt is made to extend the leg it cannot go very far without causing pain. This sign is also indicative of sacro-iliac involvement.

Rheumatic lumbar spine and troubles about the sacro-iliac joint are fruitful causes of sciatica. While sciatica is often called rheumatic, I do not believe that it is ever rheumatic except as just mentioned.

The pyriform muscle having its origin within the pelvis and passing out through the great sacro-sciatic foramen and attached to the great trochanter is often subjected to pelvic disturbance, causing contraction of the muscle which produces pressure upon the pudic and sciatic nerves, causing pain.

Treatment.—A simple test will differentiate sciatic neuritis from muscular spasm.

Connect a small high-frequency vacuum electrode to one side of a static machine, with the opposite pole grounded and the patient insulated. Place the electrode over the sciatic notch of affected side; keep the electrode in place three minutes; strength of current at point of toleration. If the pain is relieved the cause will be found to be due to muscular spasm. If the pain continues or is aggravated

the case of neuritis and should be treated as neuritis elsewhere.

Myofascic spasm is relieved by static and high-frequency sparks. Cases of spasm which do not yield readily to other methods should be exposed to X-rays.

Tetanus—Radiate over the spinal muscle every second day for 5 treatments. Each treatment should consist of one-third of the dose. If the pain be increased by the first treatment is a favorable sign. The second séance may be given after a period of ten days.

SHOCK.

Shock, when due to surgical operation or anesthesia, is accompanied by a sudden fall in blood-pressure. If the 7th cervical vertebra or the spaces between it and the first dorsal be compressed, the vagus and sympathetic branches to the heart will be stimulated to normal vibration and the blood-pressure raised.

Radiant light and heat will stimulate the deep centers, increase the force of the heart and raise the blood-pressure. Especially is this true in shock from injuries or surgery.

If in surgery which necessitates the opening of the abdomen the operation be done under strong radiant light, the chances of the supervention of shock are materially lessened.

SINUSITIS.

Infections of the nasal sinuses may be treated successfully in many cases by zinc ionization. Dr. A. R. Friel, of London, in his book on "Electric Ionization," gives the following technic: To fill the infected sinus completely and keep it full is the *sine qua non*. To attain this end the posterior nares require to be blocked. A small balloon, made of a rubber finger-stall, fastened securely to a straightened vulcanite eustachian catheter, is passed through one

or other nostril into the postnasal space. After introduction it is inflated with air. The *maxillary antrum* is punctured through the inferior meatus with a trocar and canula, and washed clean. The canula is removed, the special terminal is introduced immediately through the same puncture, and the cavity filled and kept full of fluid trickling from a receptacle attached to its outer end. The patient lies on his back with the head turned to the affected side. The strength of the current used is 10 to 15 milliamperes for fifteen minutes.

Frontal Sinus.—The frontal sinus is washed out and ionized through the fronto-nasal duct, the patient lying down. When the insulated catheter is introduced, the patient hangs his head over the head of the table, the foot of which is well raised, and a current as strong as can comfortably be borne is passed for fifteen minutes. The balloon is kept in the post-nasal space.

Sphenoidal Sinus.—In sphenoidal infection the patient lies on his back, with the table horizontal. If the ethmoid cells are involved in the suppuration, these must be treated before dealing with the other sinuses. Friel says, "To expect an empyema of the antrum, in proximity to suppuration in the ethmoidal cells, will be cured by ionization, is to court disappointment."

Ethmoidal suppuration requires treatment by operation before dealing with the antrum.

In infections of the nasal sinuses by the strepto- and staphylo- coccus, if seen early much may be done in limiting the consequences by application of radiant light and heat or heat from incandescent lamps to the point of toleration for at least one hour three times a day.

STRICTURE OF THE URETHRA.

Vacuum tube currents may be of service in removing spasmodic stricture, but I doubt very much their being of service in the organic form. Strictures resulting from gonorrhea may be removed by electrolysis. I have cured over 100 cases by this method.

Technic.—First ascertain the size and location of the stricture, then place a well-soaked pad on the abdomen and connect to the positive pole of a direct continuous current.

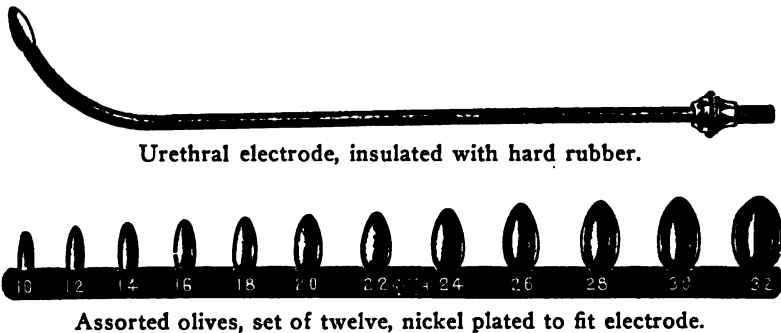


Fig. 89.—Urethral electrodes.

Connect the negative pole to an olive-shaped urethral electrode (Fig. 89), one size larger than the lumen of the stricture; pass the electrode down to the stricture and turn on the current gradually up to from 3 to 5 milliamperes; keep the electrode in contact with the stricture by gentle pressure until it passes, then withdraw the electrode through the stricture and turn off the current gradually to zero before removing the electrode from the urethra. Repeat the treatment every seven days, each time using a larger electrode until the normal caliber of the urethra is restored. There are a few old strictures that will not yield to this treatment. Strictures that have been operated upon are very rebellious and often incurable.

SYCOSIS.

Sycosis is generally a disease characterized by inflammation of the hair follicles, usually of the beard, and due to microbic infection. The skin is usually infiltrated and there are formed upon it papules and pustules perforated by hairs. There are many types of the disease.

Sycosis of the beard is commonly called "barber's itch."

Treatment.—The parasitic type of the disease usually yields to one intensive treatment by x-ray. *Sycosis vulgaris* is better treated by the fractional method.

When it involves the entire face direct each treatment at right angles to the previous one. If there be but few papules or pustules mild desiccation will cure.

SYPHILIS.

It is well known that high-frequency currents are useful for the absorption of exudates, and it is also well understood that diathermy and auto-condensation induce hyperemia, stimulate metabolism and increase elimination. Inflammatory deposits without regard to character are capable of absorption by high-frequency currents when properly applied. Therefore, it is but logical to employ them for these conditions in syphilis. Let it be understood that these currents have little if any effect, *per se*, upon the spirochete, but their ability to promote reparative processes, stimulate phagocytosis and increase elimination makes them an ideal adjuvant in the treatment of syphilis.

We have been taught that mercury is a specific in syphilis, but many times it fails in patients with faulty metabolism. Salvarsan, the first great aid in syphilis, often fails for the same reason. When these agents fail diathermy and auto-condensation prove their value by their ability to dilate blood-vessels, permitting a better diffusion of mercury,

iodine and arsenical preparations through the entire body. The high-frequency currents enhance the effects of these drugs and materially shorten the time of treatment. In chronic conditions such as adenitis, arthritis, gumma and tabes the high-frequency currents deserve a permanent place in therapy.

The actinic rays are very useful in the treatment of syphilitic skin conditions.

TATTOO, POWDER, AND COAL MARKS.

The pigments of tattoo dyes, powder and coal may be removed by the following technic: The stained area is desiccated with a fine needle by cross lines about $\frac{1}{8}$ inch apart (#). The desiccated epidermis is removed with a blunt curette. The desiccated area is then macerated for three days with salt solution, after which the pigment, powder or coal may be removed by means of a spud curette. The wound heals rapidly. Be careful during desiccation not to overheat the part as keloid may result.

TONSILS, DISEASED.

Practically all diseases of the tonsils are situated in the crypts; at least this is true in their incipiency. The crypts are near the surface and may be easily reached. Generally speaking there is no greater reason for the enucleation of a tonsil than there is for amputating a penis for chancroid.

Treatment.—Hypertrophic or enlarged tonsils are successfully treated by desiccation and the patient saved from the dangers of tonsillectomy, which, by the way, are not so few as we are led to believe. The method is a simple one: A special electrode, one known as the Soule cautery vacuum electrode, insulated (Fig. 90), is satisfactory, but any well-insulated small-point electrode will do. The application is made with short contact in each one of the crypts

of the gland and over the surface producing a slightly seared appearance. No more than 3 or 4 crypts should be treated at a sitting as an uncomfortable edema might follow the treatment of an entire tonsil. If a second treatment is required to the same area it should not be repeated in less than seven days. A local anesthetic of procain is used and very little discomfort is experienced by the patient.

The treatment closes all channels to infection and the results are in every way satisfactory.

Another satisfactory method of treatment by zinc ionization may be employed.

Technic.—After the tonsil has been rendered non-sensitive by procain, each crypt is ionized by a sharp-pointed



Fig. 90.—Soule tonsil cautery vacuum electrode, insulated.

electrode of pure zinc (Ionization Electrode No. 5). The indifferent or negative electrode is placed over a well moistened pad and placed securely in position on the back of the patient. At first it would appear that the ideal location would be on the neck opposite the tonsil, but this location should not be chosen on account of the proximity of the vagus nerve which, if irritated, might give rise to unpleasant symptoms, 3 to 5 milliamperes for two or three minutes to each crypt are required.

This method, while efficient and better than tonsillectomy, is not so easily applied as desiccation. Plank, of Chicago, states that properly projected ultra-violet rays may be satisfactorily used in the treatment of simple hypertrophic tonsillitis where tonsillectomy for any reason is contraindicated. He cleans out the crypts and applies the Kromayer lamp as follows: Using the direct current for the lamp, he places the rheostat on the 4th button, allowing

it to burn for three or four minutes before starting the treatment. He places a wooden depressor on the tongue, laying his special tonsil applicator across this, pushing the anterior pillar to one side until the applicator comes in contact with the tonsil, where it is held from two to four minutes. A distinct shrinking of the tonsil will occur in from twenty-four to forty-eight hours. After the second day the tonsil will appear yellow, due to destruction of the superficial blood-vessels. It requires 8 to 10 treatments.

With these methods at our disposal, a choice of which depends upon the individual conditions present, it would seem almost malpractice not to at least try them before a tonsillectomy be done.

TRACHOMA.

From the standpoint of public health trachoma is a very important disease especially when it occurs in children attending school. About 5 per cent. of all blindness is caused by this disease.

While trachoma presents a condition of granular conjunctivitis, not all granulated lids are caused by the diplococcus of trachoma; and a differential diagnosis is desirable on account of its contagious character, but from the standpoint of electrotherapy the differentiation is immaterial as the technic of treatment is the same.

Treatment.—I do not wish to be understood as advocating a method of treatment as a cure for all cases of trachoma, but the metallic ionization of copper is worth a trial in this intractable disease.

Technic.—A thin piece of pure copper is fashioned into a circular form $\frac{1}{4}$ inch in diameter, this to be the active electrode, and attached to the positive pole of a constant current. After complete anesthesia of the eye by procain, the same electrode of pure bare copper is applied to the

granulations and kept moving during the treatment to prevent adherence to the membrane; but care should be exercised in the movement not to break the current.

A current strength of 3 milliamperes is used for sufficient time to tinge the part a pale green. The treatment is followed by an inflammatory reaction which will soon subside under applications of hot solution of boric acid.

TUBERCULOSIS.

Tuberculous adenitis is a condition amenable to radiotherapy. The technic is filtered semi-intensive or intensive treatment. In certain cases of *tuberculous peritonitis* röntgenotherapy is very serviceable.

Technic.—The abdomen is divided into four areas, each receiving intensive treatment successively for four days which constitutes a séance. The séance is repeated once a month. Care should be exercised not to overlap the treatments. Tuberculous ostitis is benefited by heavy diathermy every third day.

Vesical Tuberculosis.—Tubercular ulcers of the bladder usually yield to fulguration or electrocoagulation.

Pulmonary Tuberculosis.—Diathermy is of inestimable value in this condition.

Technic.—Apply a large electrode anteriorly and posteriorly over the affected area as in pneumonia and pass a current of 500 to 1000 milliamperes through the lung for forty to sixty minutes. In some cases the cough and expectoration will be increased for several days and the patient will be inclined to think he is made worse, but he should be advised of this before commencing treatment. Gradual improvement will ensue and after one to three months the bacilli will disappear from the sputum.

If there be a history of previous hemorrhage proceed with caution, with small milliamperage and short time until you are assured that there is no likelihood of hemorrhage.

A few röntgenologists have reported successes in pulmonary tuberculosis by radiotherapy. Dr. J. D. Gibson, of Denver, has probably made more painstaking investigation into the effects of x-ray upon the lung than any other physician, but his conclusions have not been verified by a sufficient number of investigators to make of them a settled matter in therapeutics. He points to hundreds of cases of tuberculosis in his practice that have recovered and at least present clinical cures.

My experience justifies the statement that there lies before us a field of usefulness for röntgenotherapy of tuberculosis, which, on development will prove one of the richest in modern medicine.

Many favorable reports have been made on the efficacy of actinic rays in tuberculosis. Heliotherapy is too large a subject to go into during the limited space at our disposal, so you are referred to the voluminous literature on the subject. The writings of Rollier, the Trudeau School, Dr. T. Howard Plank and others are to be mentioned as worthy contributors to the subject.

The ideal place of residence for the tuberculous are the moderately elevated plateaus of Colorado where he can be kissed by the actinic rays of the sun three hundred days in the year. The higher the altitude the more actinic rays from the sun available, but for other reasons too high altitudes should not be chosen by those affected with tuberculosis.

VAGINITIS.

The human vagina in its normal state harbors many types of bacteria. When it becomes infected with specific germs an inflammation of its lining membrane results and the condition is known as vaginitis.

Treatment.—When sepsis is present vaginitis should be treated by zinc ionization. It does not matter whether the

infection be by the gonococcus, strepto- or staphylo- coccus or colon bacillus, zinc ionization will cure the condition provided the ionized solution reaches every point of infected surface. If the infection is also within the uterus or urethra favorable results cannot be expected.

Technic.—An electrode that will completely occlude the vaginal orifice is required. Distend the vaginal canal with an isotonic zinc solution. Before doing this, any discharge present should be removed by douching or swabbing. If the vulva is also involved, this should be covered with several layers of lint, spreading out the labia. It is necessary to keep the canal distended with the solution during the entire time of treatment. This is easily accomplished by the pressure from the reservoir containing the solution. Care must be taken not to allow the metal part of the electrode to touch any part of labia or vagina as it would cause a severe burn. Otherwise the treatment is the same as for Abscess.

VARICOSE VEINS.

The sinusoidal current of sufficient strength to produce contraction of the leg muscles will be of service in the management of varicose veins of the lower extremities.

Place the foot in water deep enough to cover. Place one electrode in the water, the other on the thigh or over the lumbar region. Turn on sufficient current to visibly contract the muscles of the leg.

A Bristow coil may also be used for this purpose.

VARICOSE ULCERS.

Radiant light and heat followed by the static brush discharge combined with the sinusoidal treatment as mentioned for varicose veins many times secures good results.

Exposure of the ulcer to x-ray is of great value. One semi-intensive treatment will often stop the suppuration.

High-frequency from a vacuum electrode applied through a layer of gauze is of service in these cases.

Zinc ionization is also an efficient method of treating varicose ulcers.

Technic.—Apply several layers of lint well soaked in zinc gelatin solution. Over these apply an electrode of block tin which has been fashioned to the shape of the ulcer and connect to the positive pole of a continuous current. The negative pad should be of large size and well moistened and placed on opposite side of the limb at least 6 inches distant from the active electrode. Turn on the current to point of toleration and continue for ten to fifteen minutes. Turn off gradually, remove the electrode but not the lint; apply bandage and do not remove the dressing for three days when the previously ulcerated surface will be found clean and covered with fine healthy granulations. Dress with sterile vaseline.

Actinic rays are also useful in varicose as well as chronic ulcers of various kinds.

URTICARIA (Hives).

This condition may be treated by the vacuum tube method but epsom salts is more efficacious.

WRITER'S CRAMP.

This is an occupational neurosis. Temporary improvement may be secured by vacuum tube treatments applied to the entire arm, but its cure lies in a change of occupation.

CHAPTER X.

DIATHERMY.

Principles of heat. Current density. Physiology. Heat and cancer. Time consumed in treatment. Painful coccyx. Inflammation and muscular spasm. Tuberculosis. Vasomotor disturbances and heart affections.

PRINCIPLES OF HEAT.

THE use of heat as a therapeutic measure dates as far back as the time when the cave man applied a hot rock to his "tummy" to relieve his distress from too free indulgence in berries and bark. We are all familiar with the soothing effects of heat from the hot brick applied by our grandmothers, as well as the hot water bottle and the electrothermic pad of today.

Our grandmothers knew nothing about the physiology of hyperemia, but they *did* know that heat applied to the skin would relieve pain. They also knew that a hot mustard foot-bath was an excellent remedy for fainting, although they knew nothing about the phenomenon known to us as shock. They knew nothing of the pathology of acute bronchitis, but they knew that a hot onion poultice would relieve soreness from a cold in the chest. They knew nothing about the causes of tonsilitis, but they *did* know that a hot woolen sock wrapped about the neck would relieve sore throat.

We are today not only able to produce the local hyperemic effects, not unlike those produced by our forefathers by crude methods, but we go still farther and bring the internal organs to any degree of heat desired. The object to be attained by thermo-penetration is not primarily to

soothe pain, but rather to bring about normal vibration and metabolism.

Heat is the result of violent agitation of the electrons of matter. Each electron has definite size and weight. During the agitation of electrons it is estimated that each one experiences five billion collisions per second. The normal movement of electrons within an atom creates a magnetic field about the atom which attracts other atoms of the substance this force being what we are pleased to call cohesion. It is this force (cohesion) that prevents any substance from falling apart. The pressure of the air from the outside is an element of cohesion. The violent agitation of the electrons tends to destroy both these forces by expansion. Expansion varies in different substances. When it is necessary to have two dissimilar substances joined, and which are to be subjected to intense heat, substances having practically the same amount of expansion must be chosen for example, glass and platinum in an incandescent lamp, otherwise a leak would cause the destruction of the lamp.

A 60 foot iron rail will expand $\frac{1}{2}$ inch in length on a hot day. The Brooklyn bridge is from one to two feet longer on a hot day than on a cold one. A telescoping joint in the middle of the span allows expansion and contraction which saves the bridge from destruction.

The atoms of fluids are possessed of little cohesive force and an outside force must be applied to hold them together, hence, their resistance to expansion is slight.

The atoms of gases are relatively far apart, hence, cohesion acts but faintly and outside pressure is required to overcome their natural expansion. An effort to compress atoms of gas causes a violent agitation known to us as heat.

An atom of any substance within which an agitation of its electrons is going on, brought into contact with an-

other atom causes a shaking up of its electrons and consequent expansion. Agitated atoms expand and, therefore, become lighter and rise above other atoms to a point where they become cool, when they again contract and fall back. When this takes place in atoms of air we call it convective heat.

The motion of air produced by convective heat we are pleased to call a breeze. Different places on the earth's surface receive different degrees of heat from the sun; the heated air expands and travels to a point where it becomes cool; the cool air rushes toward the heated point and we call this movement of atoms of air *wind*.

To measure the degree of agitation of the electrons of any substance, a meter which we call a thermometer has been devised. The thermometer is not an implement of precision, but when carefully made and seasoned it is approximately correct.

When the energy which we call heat is communicated from one atom to another of the same substance we call it heat conduction.

Heat in relation to mechanical work is measured in British thermal units (B.T.U.). A "B.T.U." is the amount of heat required to raise the temperature of 1 pound of pure water 1° F. One "B.T.U." is equal to 778 foot pounds.

The French heat unit is called a *calorie* and represents the heat required to raise the temperature of one kilogramme of pure water 1° C. One "B.T.U." equals 0.252 calorie.

All vital energy and activity come from the combustion of organic material. The more fuel we burn the greater our activity and vitality. It is therefore apparent that stimulation of oxidation or metabolism raises the energy of the organism and is of first importance in the conservation of health.

Body oxidation may be summated in various ways. The greatest factor in producing oxidation is muscular exercise, its beneficial results being due to increased metabolism. The steam boiler without means for escape of steam would soon blow up. The heat generated in body oxidation is enormous, and if it had no means of dissipation it would, in a few hours, rise to a point incompatible with life. Sixty calories of food fuel will raise the temperature of the human body 2° F. in one hour if it has no means of escape.

Radiation of heat from the body is influenced by the temperature and humidity of the surrounding air. The greater the variation of the temperature, the more rapid the dissipation. The greater the humidity of the surrounding air, the less the radiation.

A large amount of water is given off in the form of vapor, in perspiration and expired air, and as vaporization of water absorbs heat a large amount of body heat is carried away in this manner. When the temperature of the surrounding air becomes the same as the temperature of the body there can be no heat radiation, and when the air becomes saturated with watery vapor there can be no dissipation of heat by vaporization. Hot dry air as well as damp cold air favors dissipation of heat.

The production and elimination of body heat are a prominent factor in the treatment of diseased conditions. The abstraction of heat from the body necessitates oxidation to replace the lost heat. Any condition that promotes heat discharge stimulates oxidation and metabolism. The rapid dissipation of heat from the body calls for more fuel to make up for the loss, which explains the increase of appetite after a drive in a cold wind.

Health and vigor are associated with active metabolism. Anything that interferes with dissipation of body heat

lowers metabolism and produces debilitating effects, examples of which we have in low diet, indoor life and sedentary habits. Laziness is often the cause of that yellow streak in humanity.

It is very doubtful whether lowering metabolism to the minimum is productive of beneficial results in any disease. On the contrary we all know the benefit that comes from increased metabolism.

Twenty-five pounds of coal a day may keep your house at a temperature of 40° , and you may be able to exist therein, but you will not be comfortable. You may be able to live on 1500 calories of food a day, but you will get twice as much out of life on 3000 calories. However, if you push the consumption up to 5000 calories you will likely clog your grates with unconsumed fuel and will have to take a few high-frequency treatments to eliminate the excess.

PHYSIOLOGY.

In 1907, de Kraft, of New York, experimented with the thermopenetrative power of high-frequency currents. His experiments proved the value of thermopenetration in all conditions where heat was indicated.

The term diathermy was applied to this method by Nagleschmidt, of Berlin, who was conducting experiments along the same line as those of de Kraft, of New York.

The name "diathermy" has been accepted as the proper term to be applied to the method by which an elevation of temperature is produced in the tissues without destructive effect.

d'Arsonval was the first man to show that high-frequency currents if allowed to pass through the body, produce an increase of temperature of the tissues, but it remained for other investigators to apply the method in the treatment of a variety of diseased conditions.

Dr. de Kraft says: "Venous congestion wherever present is relieved because of the marked activity of the arterial circulation. Anemia of the splanchnic area ensues. Visceral congestion is relieved. The liver, the intestines, and other organs within the abdominal cavity are made to disgorge the stagnant pools of blood which bathe their structures. When the action of the diathermic current has subsided and the blood stream returns again to its normal channels, freshly oxygenated arterial blood enters in greater abundance into the previously anemic and (before the heating) venously congested areas. The parts are placed in a better state of defense against the invasion of toxins and bacterial colonies."

The passage of a diathermic current through the lungs causes less consumption of oxygen as well as a reduction of carbon dioxide in the exhalations. This demonstrates that when heat is introduced into the body from the outside less heat is formed from within. However, it has been proven again and again that during treatment by auto-condensation there is a marked increase of carbon dioxide given off by the lungs and an increased output of nitrogen by the kidneys.

It will be found that in individuals with subnormal temperatures the application of diathermy will raise the temperature to normal, improve the appetite, increase weight, promote sleep and a feeling of comfort. Diathermy causes a more or less anesthesia of the skin covered by the electrodes. After a few minutes application of diathermy to a joint the patient often complains of pain due to the intense hyperemia produced, but it lasts only a short time.

Continuous currents of electricity take the route of least resistance, but high-frequency currents take the shortest route between the electrodes. Bones offer the greatest resistance of any part of the body to the passage of high-frequency currents while the skin offers but little resistance. High-frequency currents meet with great resistance in pass-

ing through metallic conductors. This characteristic of the high-frequency current is directly opposite that of the continuous current, the resistance to which decreases as the size of the conductor increases.

Dr. George W. Crile says: "In what way may heat exert its beneficial influence? Grant the premise that the natural defense of the organism against infection is made through the agency of phagocytosis and the chemical antagonism of the blood plasma, it becomes evident that in either case the defense is chemical. The fact that the defense is chemical gives at once a clue to the mechanism by which heat assists the defense against bacteria. It is probably because with the rise of each degree in temperature in any system, inorganic or biologic, the chemical activity is increased 10 per cent. and the electric conductance $2\frac{1}{2}$ per cent. The increased chemical activity increases the chemical defense; the increased electric conductance increases the metabolism. Therefore, we may suppose that heat accelerates the chemical defense as far as it involves chemical defense of the blood plasma, and that the heat aids also by increasing the total amount of blood in the inflamed part, thereby increasing the number of phagocytes. Moreover, heat assuages pain."

HEAT AND CANCER.

By extended experiments it has been found that normal cells of the body are able to withstand a temperature of 140° F., while cancer cells are destroyed by a temperature of between 122-131° F.

Many experiments have been made to ascertain the form of heat that would destroy cancer cells within the body without endangering normal cells, but so far we are unable to accomplish anything along this line. However, we are able to destroy malignant growths at or near the surface of the skin by the Massey method of zinc ionization, the Doyan

method of thermo-coagulation and the desiccation method of Clark.

In simple diathermy two electrodes of large size are employed and so placed on the surface of the body that the current passes through the part under treatment. Contact must be perfect, the sole object being to heat the tissues without injury.

CURRENT DENSITY.

There are a few basic points in the application of diathermy which it will be well to remember: The density of a current varies in accordance with the area of the electrodes. The density increases in inverse proportion to the square of the surface of the electrodes. For example: An electrode 8 inches square contains 64 square inches and another 4 inches square contains 16 square inches. If the 8-inch electrode be placed on one side of the body and the 4-inch electrode on the opposite side, each square inch under the 4-inch electrode will receive four times the heat of that under the 8-inch electrode.

This knowledge of the density of current enables us to concentrate heat at the point desired. For example, in pneumonia, we find the affected area to be near the anterior portion of the lung, and, desiring to concentrate the heat at the point of greatest activity of the disease, we place a large electrode on the back and a small one in the front. If the disease is one of an entire lobe involvement we use electrodes of equal size.

Theoretically the effects of heat currents vary as the square of the amperage. For example: If we are giving a milliamperage of 200 and change to 400 we have doubled the meter reading but quadrupled the heat effects; and if we increase the milliamperage from 200 to 800 or four times the milliamperage, we have increased the heat effects sixteen times.

In practice upon the living subject this principle does not hold true, because, when strong currents are employed the reflexes are stimulated to such an extent that all the functions which regulate the heat in the body are stimulated to fight the heat from the outside, but when the smaller current strength is employed the reflexes are not stimulated, allowing the heat to get by.

It has been found by placing one electrode on the back and the other over the epigastrium that the temperature within the stomach is higher when a current of 300 milliamperes is employed than when one of 2000 milliamperes is employed. This experiment was tried on a living dog and then the dog was killed. After death the temperature in the animal's stomach was raised by the current in proportion to the milliamperage employed.

The current between two electrodes passes in a straight line and the heat upon dead tissue is practically the same throughout. If there be any difference, the part midway between the electrodes is the point receiving the greatest heat.

As a general rule we should employ electrode surface of about 15 square inches for each 1000 milliamperes of current employed. Wherever possible the electrodes should be securely fastened by means of a roller bandage. When employed on the back of a patient the weight of the body may secure proper contact. On the front of the body the electrode may be weighted down with sand bags or held firmly in place with the hands.

We must be very careful to secure an even contact of electrodes to prevent burns and concentration of current. Usually the sensation of the patient will be our guide in diathermy treatments; at any rate, do not go beyond the toleration of the patient. Sometimes, as in cases of skin anesthesia, the sensation of the patient is no guide at all,

but we are usually aware of this condition before we make the application. Again, it sometimes occurs that the first contact anesthetizes the skin to such an extent that we may get a burn in spite of all our precautions. Never forget to advise the patient of the possibility of a burn while under treatment by diathermy, as it may save a suit for malpractice.

If you desire a greater effect than the patient seems to tolerate, reduce the amperage and lengthen the time. Better results are usually obtained by low amperage and long time than by high amperage and short time. Naturally the more tissue between the electrodes the greater the resistance, and this must be taken into consideration in choosing the size of the electrodes to be employed.

Due consideration must be given to the amount of heat lost in radiation from the surface as well as by conduction by the dilated blood-vessels—the body's main defense against burns. Up to a certain point the body defenses are overcome. Muscle and bone give up heat slowly, consequently, when we are able to raise the temperature within them by several degrees, the heat is retained for hours.

While the skin loses heat rapidly by radiation and the soft tissues immediately underneath the skin lose heat by conduction through the dilated blood-vessels, the muscles are giving up their heat and the bone marrow is absorbing it and becoming warmer. This action of heat upon bone marrow increases the number of red blood cells and the output of hemoglobin. This increased output of hemoglobin produces a tonic effect upon all the cells of the body. This is the main reason for the beneficial results secured by diathermy in wasting diseases like tuberculosis.

TIME CONSUMED IN TREATMENT.

It is quite probable that there exists in the mind of the reader at this time the query: What time should be consumed in a treatment by diathermy? This question cannot be answered directly, because so many elements have to be considered in each individual case.

The resistance of the skin, the thickness of fat underneath the skin or anywhere between the electrodes, the moisture of the tissues, the density of all the tissues, the reflexes of the patient, the distance between the electrodes, the size of the electrodes and the degree of temperature desired, all enter into the consideration of time for each treatment.

The better these conditions are understood, and the better the diagnostic skill of the operator, the better the results. The operator who is able to generalize the disease and individualize his patient will succeed where the careless will fail.

While in auto-condensation you will be able to heat up an obese patient in less time than you can a thin one, the opposite is true in diathermy. If we are compelled in an arbitrary manner to state how long we should diathermatize, we would answer, fifteen to thirty minutes. In some instances we are able to secure the desired result in fifteen minutes, while in others it will require an hour to produce the same results, for the reasons heretofore mentioned.

If you have any doubts concerning the deep effects of diathermy, place an electrode in the rectum, the other just above the pubes of a female, introduce a speculum into the vagina, turn on the current and watch the effect upon the cervix; or diathermatize a larynx and watch the blood-vessels dilate through a laryngoscope or watch the rectal thermometer in diathermy of the pelvis. Seeing is believing.

You can readily understand by the physiology of diathermy when and where to apply it.

PAINFUL COCCYX.

We all have cases of painful coccyx. Most of these cases are caused by falls, injuring the end of the spine. Before the days of high-frequency these cases gave us much annoyance, but now we are relieved of annoyance and our patients of pain. The technic is simple: Place one metal electrode in the rectum and the other over the painful area and use a mild current—from 100 to 200 milliamperes being sufficient.

INFLAMMATION AND MUSCULAR SPASM.

Inflammation of muscles and tendons, produced by strains and direct violence, as well as traumatic synovitis, is relieved by diathermy. The most prominent symptoms are swelling and pain on movement of the affected muscle or joint, mainly due to spasm of the muscle.

In these cases the treatment employed by those who do not possess electrical modalities consists of strappings by adhesive tape or plaster of Paris casts. The object in view is to secure rest for the parts. What is the object of rest? First, it prevents muscular spasm; second, it promotes adhesions which require breaking up afterward. This is the experience of us all.

The proper management of these cases consists first of relieving muscular spasm and then promoting absorption instead of organization of the infiltrate. Infiltration always occurs in these injuries. Nature inaugurates a process which we call inflammation, evidenced by hyperemia and consequent heat in the parts. The effect of strappings and plaster casts is to limit this effort of Mother Nature and, unfortun-

ately, delay the reparative process. Why not take a tip from nature and assist her by the application of diathermy?

Diathermy promptly relieves muscular spasm and hastens absorption—the two things necessary to the restoration of the parts to normal. After a few days' treatment by diathermy stimulation in the form of static wave current, or, possibly static sparks, will clear up the last portion of the infiltrate and your patient be well.

The same treatment applies to subluxation of the hip, knee, sacro-iliac and other joints.

This treatment does not apply to infected joints nor infectious cellulitis unless there is free drainage. Some observers have reported most highly beneficial results from diathermy in cases of infected joints as well as tuberculosis of bone where there is good drainage. One can readily appreciate why this would be true in such cases.

The effects of x-rays on infected joints are destructive to germ life, but let me caution you not to employ this agent unless you are familiar with its effects and details of application.

CIRRHOSIS OF THE LIVER.

In cirrhosis of the liver, where it may be increased to double its size, the static wave current will give prompt relief. The technic is: Place a large electrode over the enlargement, with the patient on an insulated platform, attach the electrode to one pole of the static machine with the other pole grounded and employ as long a spark-gap as may be consistent with the comfort of the patient.

In the stage of atrophy, where ascites and more or less edema have occurred, the employment of diathermy will give great relief by passing a current of toleration through the liver. It should be used daily for twenty to thirty minutes until results are obtained. While this does not cure

the patient, it is a source of great relief to patients with nutmeg liver, and extends to them a benefit that cannot be realized by any other therapeutic measure.

TUBERCULOSIS.

There are so many elements to be considered in tuberculosis that no orthodox method of treatment will fit every case. I cannot believe that there ever was a purely uncomplicated case of pulmonary tuberculosis. As a matter of fact, we all are now or have been infected with the tubercular germ, but the majority of human beings has established an immunity to the disease. However, 10 per cent. of the deaths in the United States, from all causes, are due to tuberculosis.

This disease always has its complications, and we are compelled to treat each individual and not the disease itself. In every case of tuberculosis there is a time when there is present a condition that we are pleased to term "pre-tubercular stage," which is analogous to the hyperpiesia stage of cardio-renal disease.

It is a well-known fact that patients suffering from mitral lesions of the heart scarcely ever suffer from tuberculosis; the reason for this being found in pulmonary congestion. The lungs being constantly bathed with an increased blood supply inhibits the action of not only tubercle but its concomitant infections.

Since the discovery of high-frequency currents we are able to heat any portion of the lung without producing a general congestion: in other words, we are able to produce arterial hyperemia of any portion of the lung. During the past five years extensive experimentation has been conducted upon large classes of tubercular patients for the purpose of proving or disproving the effects of diathermy. The greater portion of this work has been carried on in

England, but ably seconded by American hospitals and individuals all over the United States. The results of these experiments have proven the value of diathermy in tuberculosis. In comparison with all other methods diathermy stands four to one in its favor in bringing about an arrest of the disease.

The effects upon the blood are: Increase in red cells, hemoglobin and lymphocytes and decrease of the polymorphonuclears. The increased hyperemia induces an increased flow of lymph and a consequent increase of expectoration. After a time, from one to three weeks, the expectoration gradually becomes less, the appetite improves, there is a feeling of improved pep, the ashen hue of the skin takes on color, the temperature falls (sometimes below normal), nocturnal sweats cease and there is a progressive increase in weight.

During my practice with diathermy I have never seen a case of pulmonary tuberculosis that did not improve under its application. Incipient tuberculosis is invariably arrested; fairly well advanced cases do nicely with about 70 per cent. of arrests; far-advanced cases do better than with any other treatment, possibly with the exception of such cases as are amenable to artificial pneumothorax.

Hypotension is the rule with the tuberculous. Under diathermy we get an increase of metabolism as well as direct cardiac stimulation with a gradual increase of all the blood pressures.

It is yet an undecided point whether the bacilli of tuberculosis are or are not inhibited by diathermy. It has been proven again and again that the growth of pneumococci, staphylo-, strepto- and gono-cocci is inhibited by diathermy.

As you may know, Colorado Springs is a mecca for the tuberculous. We, who have lived there for many years,

have had wide experience in the management of *not* tuberculosis, but the individual who is tubercular. We have gradually developed a number of specialists in this disease. A short time ago one of this number, a physician who has made tuberculosis a study for forty years, said to me that he secured positive results from diathermy in the treatment of tuberculosis. I said to him: "You have been known to me for twenty-five years as a skeptic about any treatment suggested for pulmonary tuberculosis." He said: "Yes, I have tried them all and I have experienced more satisfaction by diathermy than all others combined." I inquired if he had ever produced a hemorrhage by diathermy, and his answer was: "Nothing more than a pinkish sputum." He added: "I ordinarily say to a patient: 'Now you have tried hygiene, climate, heliotherapy, drug therapy, vaccine and serum therapy, chemo-therapy and everything else ever suggested to you, now let us try diathermy. It may cause a profuse hemorrhage, but I have been getting results in all stages of tuberculosis; suppose we try it.'"

This kind of talk appeals to his patients; he goes ahead and, in many cases, secures at least an arrest of the disease. He described to me a case of tubercular abscess of the lung which involved one entire lobe, there being a free communication with the bronchus which allowed free drainage. After each treatment by diathermy there was an abundant expectoration of pus. This continued for four weeks, gradually reduced in quantity and tenacity, finally ceased and he considered his patient well. I inquired about hemorrhage in this case. He said, "he spat blood like the devil for a few days but came around all right."

I never treat a case of pulmonary tuberculosis by diathermy when I have any reason to suspect a hemorrhage, but my friend, just mentioned, treats cases that have had

repeated hemorrhages and he gets by with "but a pinkish sputum."

When should we dithermatize in cases of tuberculosis? The patient's temperature is a fairly good index. If the temperature is not over 100° F. at any time, we are quite safe in the use of diathermy.

The technic already described under pneumonia is applicable in pulmonary tuberculosis, with, perhaps, the addition of directing the current through the mediastinum, to bring under its influence the bronchial glands—the original seat of the disease.

I must add that the field for the treatment of pulmonary tuberculosis by diathermy is a very promising one. Many a poor fellow has been committed to an asylum with depressive insanity from autointoxication, who could have been saved by proper application of high-frequency currents.

VASOMOTOR DISTURBANCE AND HEART DISEASE.

Almost daily we see patients complaining of vague pains, cold hands and feet, that tired feeling and more or less cardiac and gastro-intestinal disturbances. Upon examination of these patients we usually find the blood-pressure reversed and below normal and no definite pathological lesion. Before the days of high-frequency currents, and today, by men who do not employ physical therapy, the treatment invariably prescribed is some illogical pepsin compound with nux or strychnine. These cases are promptly relieved of their vasomotor disturbance by application of diathermy with one electrode over the dorsal region, the other over the epigastrium. The electrodes employed should be of large area. It is possible that in addition to the correction of the vasomotor mechanism the heat from diathermia promotes the activity of the body ferments which assists in bringing about good results.

Diathermy applied directly to the heart will often regulate the arterial tension. The explanation of this action is found in the arterial dilatation that takes place within the heart muscle which increases capillary efficiency, thereby improving strength and nutrition of the heart muscle.

I know of no condition where cardio-diathermia is contraindicated.

CHAPTER XI.

PAIN.

Definition. Painful stimuli. Classification of pain. Susceptibility to pain. Systems of sensibility. Pain in diseases of the food tube. Neuralgia and neuritis. Headache. Backache. Shoulder pain. Bursitis. Treatment of bursitis. Sciatica.

DEFINITION.

ABOUT 90 per cent. of all diseases either commence with or have pain as a symptom at some time during their course. Pain is defined by Webster as "an ache," and by Gould as "a distressing or agonizing sensation," whereas, pain is distinctly a mental interpretation of a harmful process which is occurring in the organism. Pain is universal. The word pain comes from the Latin, "poena," meaning punishment. The mind interprets three kinds of sensations, *viz.*: pain sensations, pleasure sensations and neutral sensations.

PAINFUL STIMULI.

The intellect is able to produce sensations of pain without any objective means, the result being known as subjective pain. The production of pain depends upon a proper stimulus. The stimuli which produce pain may be divided into those due to pressure, to toxemia, to chemical, electrical and thermic reactions. As a rule pain of equal intensity cannot be felt in two places at the same time, for the mind is capable of interpreting but a single sensation at one time.

CLASSIFICATION OF PAIN.

Tenderness may be present over the area in which the pain is complained of, but which is not the area of the lesion.

Pain may be absent over the area of the lesion and be found at some distant point. A few examples: Pain from gastric ulcer may be felt over the eighth and tenth dorsal vertebræ; from gall-bladder it may be felt under the right shoulder blade; from tabes it may be felt in the epigastric region; pain may be felt in the heel from lumbar arthritis; pain along the sciatic nerve is likely to come from trouble in the sacro-iliac joint; pain and hyperesthesia along the ulnar side of the forearm may come from angina pectoris; pain underneath the sternum may come from appendicitis, etc.

Then we have emotional pain, subjective pain, associated pain, referred pain, organic pain, functional and habit pains. When the painful stimulus has been transferred from one cell to another, or by crossing of nerve fibers, it is known as an associated pain. Headache from eating ice cream belongs to this class.

Referred pain is one in which the irritation occurs along the course of the nerve fibers and the pain is felt in the peripheral distribution of the affected nerve. Referred pains are very common. In order to determine the viscus causing referred or reflected pain it is necessary to delimit the area of hyperalgesia as nearly as possible and orient it with a cord segment. Find the organs supplied by this segment and examine the organ or organs for disease. See if the pain can be reproduced by manipulation of the organ.

SUSCEPTIBILITY TO PAIN.

Susceptibility to pain varies with the individual, light skins being more susceptible than thick ones to peripheral irritation. Unsusceptibility to pain may be due to lack of mental development. Will power may be so intense as to produce immunity to pain.

There are many degrees of intensity of will power to withstand pain produced by psychic influence. Emotional

influence may be strong enough to overcome the interpretation of the stimuli which ordinarily produce painful sensations. Again, the emotions may be carried to such a high pitch as to transfer pleasure sensations into those of pain.

The influence of the teachings of Christian Science, which, by the way, is neither christian nor science, tends to develop a will power of sufficient strength to obtund the nerves to painful stimuli or change them into neutral sensations. This is the sum and substance of the healing power of so-called Christian Science.

When a patient enters the office complaining of pain, the first point of consideration will be to satisfy ourselves whether pain actually exists. We have to deal not only with malingerers but with those who do not distinguish between pain and other sensations such as pressure, vague discomfort, etc. Pain may be simulated or exaggerated. A patient apparently suffers more when friends are near than when alone. He may pity himself when others are present.

When a patient presents himself for the relief of pain, his general appearance, his attitude and his story are all scrutinized. If his general appearance does not coincide with his story we at once come to the conclusion that he exaggerates. When he states that he has suffered continual severe pain for a week, a month or more, and bears no time-marks of pain, we suspect that he is malingering. When we suspect this we take his blood-pressure. If much pain exists it will be found higher than normal.

The words "awful," "fearful" and "terrible" excite our suspicions. The individual susceptibility to outward influences has considerable influence upon his vocabulary. If he be very voluble and uses awful words to describe his suffering, a gentle test of his reflexes will obtain evidence

worth while in deciding his case. Exaggerated reflexes indicate a state of oversensitiveness. Usually a cross-examination of his story will bring out the real character of his sufferings. Diversion of a patient's attention seems to reduce his suffering, but, because of this, do not err by underestimating the intensity of his pain.

Description of the character of pains by the patient is sometimes likened to some sensations which he has experienced in the past and may be of value in diagnosis as of lightning pain in tabes, the *gnawing* pain in rheumatism, the *burning* pain in neuritis, the girdle pain in spinal disease, the cap or band pressure pain in neurasthenia, the sharp *cutting* pain in neuralgia and the *dull aching* pain in infectious diseases.

Sensations may be both painful and pleasant: Pain and pleasure are but attributes of sensation. Heat, cold, taste, smell, sight and hearing may all be painfully as well as pleasurably perceived.

SYSTEMS OF SENSIBILITY.

According to Head the systems for conveying sensations, with the stimuli which they carry, are:

1. *System of Deep Sensibility* which, upon excessive deep pressure conveys a sensation interpreted as pain. This sensation is caused by alterations in the position of joints, muscles and tendons.

2. *System of Protopathic Sensibility* which conveys painful cutaneous stimulations of heat and cold, visceral sensation, painful sensation from a prick and electrical stimulation.

3. *System of Epicritic Sensibility* which interprets light touch, character of touch and slight differences of temperature. This form is concerned with the discrimination of the finer variations of sensation and does not transmit pain.

This form of sensibility is lost to return after section of a cutaneous nerve.

Pain may be *constant*, *intermittent* or *remittent*. When constant it calls for investigation into conditions which act constantly, such as new growths which press upon the nerve fibers somewhere in their course. When the pressure is constant the pain is also constant, but it is usually referred to peripheral distribution of the nerve fibers.

If an inflamed mass has periods of less congestion, these periods will be accompanied by pain of a remittent character: a remission of pain may be complete for a time again to reappear. This form is known as intermittent pain. Pain of intense paroxysmal character is known as *crises*. It comes suddenly and as suddenly disappears. This form of pain is usually caused by muscular spasm, and the cause of the muscular spasm may be far removed from the site of pain. Pain from muscular spasm is usually worse at night, as sleep produces muscular relaxation, and any slight movement during sleep causes a sudden contraction or spasm of muscles, producing pain.

PAIN IN DISEASES OF THE FOOD TUBE.

Pain coming on during digestion occurs only when there is some disease of the food tube or organs closely related thereto. Pain coming on during ingestion of food points to disease of the esophagus or cardiac end of stomach; immediately following ingestion of food gastric ulcer is indicated; two or three hours after taking food, we suspect a duodenal ulcer; three and a half to four and a half hours after food, gall-bladder disease is thought of, if pain comes on five or six hours after ingestion of food we suspect trouble with the appendix or colon. On the other hand, if ingestion of food relieves pain, duodenal ulcer and carcinoma are thought of.

A large proportion of patients who come to the electrotherapist for relief are suffering from muscular spasm. Spasm of certain muscles producing pain leads us to investigate all the joints, periosteum, bone and all tissues and organs liable to inflammation in the neighborhood. Flexion of the thigh may cause a pain in the lower right quadrant of the belly—which may mean appendicitis.

Affections of nerves or nerve trunks are always due to pressure from within or without produced by congestion, inflammation, traumatism and toxemia.

NEURALGIA AND NEURITIS.

The milder grades of pain may, for the purpose of convenience, be termed neuralgias, and the more severe affections, neuritis. We can hardly insist upon a separation of neuralgia and neuritis, because the distinction is one of quantity rather than quality. A severe neuralgia may be termed neuritis; a mild neuritis, neuralgia. All operative causes of neuralgia and neuritis are the same, the term applied depending upon the severity of the exciting factor. Exposure to cold may be of such an irritative nature as to cause neuralgia. This is especially true in the face. The irritant, cold, may be severe enough to set up a neuritis. The neuritis may cause motor disturbance of a greater or lesser degree of import. The sensory nerves may be but slightly irritated and pass the irritation along to the motor apparatus and cause temporary paralysis. Slight trauma associated with the irritant, cold, is a frequent cause of neuritis.

The lodgment in the nerve or nerve sheath of auto-toxic or hetero-toxic substances such as phosphorus or mercury may cause a neuralgia or a neuritis. To my mind there is this distinction between neuralgia and neuritis: Neuralgia

has no pathology and is, therefore, a symptom; neuritis has a distinct pathology and, therefore, is a disease.

Neuralgia is a term given for nerve pain. Its causes are numerous. The main differential points of diagnosis are: In neuralgia there are painful points of hyperesthesia and the course of the nerve is not painful to pressure, while in neuritis the course of the nerve is tender under pressure. While a neuralgic pain may be constant, it is likely to be interrupted and the paroxysms alternate with periods of freedom from pain. The pains of neuralgia may be felt at distant points from the lesion. They are usually found at the point of emergence of nerve trunks or where a nerve trunk traverses a muscle to reach the skin. Sometimes a slight pressure increases a neuralgia pain and a deep pressure relieves it.

Injection of cocain will ease the pain of neuralgia but will have no effect upon referred pain.

The pain of trigeminal neuralgia is probably the most severe form of any to which man is heir. It may occur in any of the branches of the fifth nerve and is, in the most severe cases, associated with a lesion of the Gasserian ganglion, when it is known as *tic douloureux*.

HEADACHE.

The most common pain complained of by man is headache. It is the leading symptom of many functional and pathological conditions. Were we to consider 1000 cases of headache, taken as they naturally come, we would find 350 to be caused by psychoneuroses; about 100 of unknown cause; about 200 from nephritis; 100 divided about equally among meningitis, sinusitis, neuralgia and migraine; 50 from brain tumor and syphilitic affections and 200 from hypertension, constipation, fatigue, hunger, eye-strain and infectious diseases. Menstruation is sometimes accompa-

nied by headache. Not a few of the pains during childhood, in all parts of the body, are due to the disturbed development of the ductless glands.

Edinger has applied the name *indurative* to a number of headaches, the cause of which is more or less unknown. Under this head are mentioned *rheumatic headache* and indurations found near the origin and insertion of muscles. The term *idiopathic*, meaning *I don't know*, might be applied to headaches the cause of which we do not understand.

Migraine is a disturbance of the vasomotor mechanism and is often relieved by that great regulator of the vasomotor system—auto-condensation.

The ingenious mapping out of the head into states, counties and townships, accompanied by a key to the location of cause of pain in some remote part of the body, is more or less a *myth*.

A pain in the top of the head is not necessarily caused by uterine disease because many men suffer from pain in this particular geographical location. Pain in the occiput may come from eye-strain or a diseased prostate. Frontal headache does not always point to gastro-intestinal disturbance—it may come from an infected frontal sinus.

Pain underneath the eye is not always caused by trigeminal neuralgia—it may come from an infected tooth or antrum. Earache does not always indicate aural disease—it may come from an infected tonsil or even an unerupted tooth. A unilateral headache does not always spell migraine. The nature of the head pain such as throbbing, boring, burning does not always indicate brain tumor. The character of headache is of little significance in diagnosis.

There is a class of headache pain that might be termed "*get the habit*" headache, the patient always being able to locate the cause as a blow upon the head, sunstroke, pto-

maine poisoning, surgical operation or certain articles of diet. A syphilitic headache is worse at night, but that does not imply that all nocturnal headaches are due to syphilis. The cause might be found in brain tumor or a poorly functioning kidney. Nocturnal headaches may be due to tobaccooid cigars, the toper's nightcap or Welsh rarebit.

The most severe headaches come from meningitis, cerebral tumor, migraine, syphilitic periostitis and tic douloureux.

The passing of a headache at about the noon hour and returning at some definite time does not always indicate malaria, although it be relieved by quinine. The pain is often due to sinusitis.

One of the causes of headache, especially in women and children is pituitary hunger which may be termed carbohydrate dipsomania or intense craving for sweets. A candy spree is often followed by a pituitary headache. The pituitary and adrenals are the commanding generals which superintend the mobilization of sugar within the body. Primarily the pituitary has charge of the sugar ration, but when overworked it becomes enlarged and exhausts itself when it calls to its assistance the adrenals and when they in turn become exhausted general fatigue results. A pituitary headache is deeply seated behind the eyes. The temples are sensitive to pressure. The pain persists from one to forty-eight hours. The spree usually terminates in nausea and vomiting. The symptoms are not unlike those of alcoholic intoxication. The liver and heavy muscles are overloaded with sugar. The treatment indicated is a cathartic and brisk muscular exercise which unloads the excess sugar until the drunk is repeated.

In locating the cause of headache, do not minimize the patient's story; it will often lead to a diagnosis of psychoneurosis or a disturbance of the vasomotor mechanism. In-

stead of following someone's map of referred pains, exercise a little common sense and examine the eyes, the nose and its accessory sinuses; take the blood-pressure and temperature and look for foci of infection; examine the urine and the blood. A Wassermann test will often clear up a difficult diagnosis. In headache therapy, above all things, do not follow that too-often-traveled road that leads to the acetanilid shelf.

BACKACHE.

Backache is an interesting subject upon which a volume might be written. A very large proportion of backaches is due to trouble of the sacroiliac joint, nine-tenths of which are diagnosed as lumbago. Lumbago or myalgia of the lumbar muscles, the causes of which are many and varied, constitutes about one-third of all backaches. Lumbago should not be mistaken for sacroiliac disease by a careful physician. Fatigue is a frequent cause of backache, but as a few hours' rest relieves the pain, the physician is seldom consulted. Backaches from infectious diseases are easily recognized.

The perusal of almanacs and Doan's Kidney Pill literature has produced in the minds of many the idea that backache means kidney disturbance, when, as a matter of fact, a diseased kidney is seldom concerned in the cause of backache. While the condition of the pelvic organs is sometimes a factor in the etiology of backache, it is far less so than usually supposed. Diseases of the uterus and prostate may, by pressure on the pelvic plexus, cause backache, but the more common result from these conditions is *legache*.

In investigating the cause of backache, always secure the patient's story and note the duration of pain; if of long duration it points to pressure or psychoneurosis. Is it unilateral or bilateral? Does stooping or bending sideways increase the pain? Does the pain radiate along the course of intercostal or other nerves?

Examination.—After securing the patient's story examine his naked back. Is a skin eruption present? Often herpes is present without the patient's knowledge, which indicates neuritis. Test the epicritic sensibility with some pointed instrument. Test the sensibility of muscles by grasping them between the thumb and finger. Is the spine rigid as a whole or in part? Percuss the tips of the spinous processes. Are they tender? Exert deep pressure over the intervertebral spaces. Does this elicit visceral reflexes? Exert deep pressure with the thumb over each kidney. Is there tenderness over the sacro-iliac joints? Test the effects upon the sacro-iliac joints by having the patient flex the thigh with the knee kept straight; by pressure on the ilium backward with the patient on his back and lateral pressure with patient on his side. Examine the pelvic organs. Make a complete urinalysis as well as blood tests and use the x-ray if indicated. The evidence obtained by examination along the lines just mentioned will justify a verdict of a guilty or not guilty spine. If not guilty, proceed with the examination of all the organs of the body until you are able to make a diagnosis, then apply rational therapy.

The usual symptoms of sacro-iliac trouble are pain and tenderness over the joint, the pain extending down the course of the sciatic nerve. There is usually a list of the body to one side. Flexing the thigh upon the abdomen with the knee extended causes pain in the joint.

The symptoms of lumbago are local pain and tenderness over the affected muscles, also pain upon bringing the affected muscles into action.

Neuritis is accompanied by a herpetic eruption and pain along the course of the thoracic or abdominal nerves.

Spinal arthritis is secondary to infection; the spine is stiff and tender; muscular spasm is usually present.

Renal stone causes pain over the kidney and along the course of the ureter; there may be pain in the testes; great tenderness upon deep pressure over the kidney; a shadow is usually seen on the x-ray plate; blood and pus in the urine.

Perinephritic abscess and pyuria are usually accompanied by an elevation of temperature. The pain is local.

Tuberculosis of the spine generally occurs in early life; the spine is rigid, not much pain. The x-ray will usually clear up the diagnosis.

A fairly large proportion of the cases that come to us for the relief of pain are complaints from the brachial and sacral plexes.

SHOULDER PAIN.

Every physician has a goodly number of patients who complain of pain in or about the shoulder. The differential diagnosis of the causes of pain in the shoulder is not entirely an easy one. Scarcely a day passes that I am not called upon to relieve pain or restore function of the shoulder joint, consequently I have paid considerable attention thereto.

About 40 per cent. of these cases are due to trauma, leaving a majority to causes from within, such as anemia, vascular changes, infections, chemic and organic poisons, diabetes, etc.

Brachial neuritis may be caused by traumatic blood clot. If the clot be absorbed the neuritis will disappear; if it becomes organized it will, by pressure, cause a wide range of symptoms. Drooping shoulders, in time, may produce brachial neuritis. Septic conditions about the joint may result in adhesions which press upon the nerve. A cervical rib may be the offender, causing neuritis of the posterior branch of the plexus. The chemical and bacterial condi-

tion of the blood plays an important part upon the physiological action of nerves.

The shoulder is supplied by the suprascapular and circumflex branches of the brachial plexus, and irritation of these nerves is likely to be reflected and cause pain in any part of the plexus. Fractures of the acromion are more common than ordinarily supposed, the most of which may be diagnosed by the x-ray.

Tenderness and pain about the clavicular-acromial juncture, following direct or indirect violence, accompanied with painful abduction of the arm, without x-ray findings, are most surely to be caused by infiltrations and ecchymoses.

Injury to the capsule of the joint may be the cause of pain. This is most likely to occur from a fall upon the hand when the arm is in abduction. Force applied in this manner often ruptures the capsule at its weakest point—the axillary side. If the rupture is complete there is usually a dislocation. Often a partial subcoracoid dislocation is overlooked. Tenosynovitis of the biceps tendon may be the cause of shoulder pain. While it may simulate neuritis or bursitis, the patient's story of causation—that of violent action of the biceps—will lead you aright.

Irregularities in the bursa are more common than many other conditions, the symptoms of which are retarded movement accompanied by crepitus and periods of exacerbation and apparent recovery.

The many arthritides, rheumatic, tubercular and infectious; fractures and dislocations and atrophic conditions from inflamed and degenerated nerve fibers somewhere in their course from the cord to the periphery; lymph exudates at points in close contact with bones—all, or any one of these may cause shoulder pain and make the diagnosis difficult. Probably a large percentage of the traumatic causes of shoulder pain is due to bursitis (Fig. 91).

BURSITIS.

The anatomical relation of these bursæ is illustrated in Fig. 91. The symptoms of subdeltoid bursitis are tenderness just below the acromial process, which disappears when the arm is abducted, unless there be adhesions or muscular spasm and some limitation of abduction and external rotation. In acute cases there is pain over the deltoid and outer side of the arm, and pain upon adduction as well as abduction. The familiar catch-pain upon adduction is significant.

Subcoracoid bursitis is not so common; however, the pain experienced down the ulnar side of the arm is similar but the hand is more liable to swelling than pain. If the *inner* as well as the outer rotation of the arm is limited and causes pain it points to subcoracoid; if adhesions have formed inner and outer rotations are lost.

The diagnosis between bursitis and tuberculosis is not always easy; the early symptoms are almost identical. Here, again, the story as given by the patient will help out. A tubercular test may clear up the diagnosis; later on the x-ray may disclose the tubercular joint, but usually not until other symptoms have made the diagnosis complete. A fracture of the anatomical neck of the humerus may simulate bursitis, but here the x-ray should clear up the diagnosis.

Arthritis may be differentiated from bursitis by observing the degree of abduction. In bursitis this is limited to a few degrees without pain, but in arthritis there is no abduction without pain.

There are three distinct stages of subdeltoid bursitis: First—stage of congestion following trauma or infection; second—stage of adhesion and contraction; third—the stage of deposit of lime salts in or underneath the bursa and marked by atrophy of the muscles of the shoulder.

Treatment.—The ordinary surgical treatment is fixation during the first and second stages, then operation followed by a repetition of all the symptoms and a fifty-fifty result.

The electrotherapeutic treatment is diathermy. If ap-

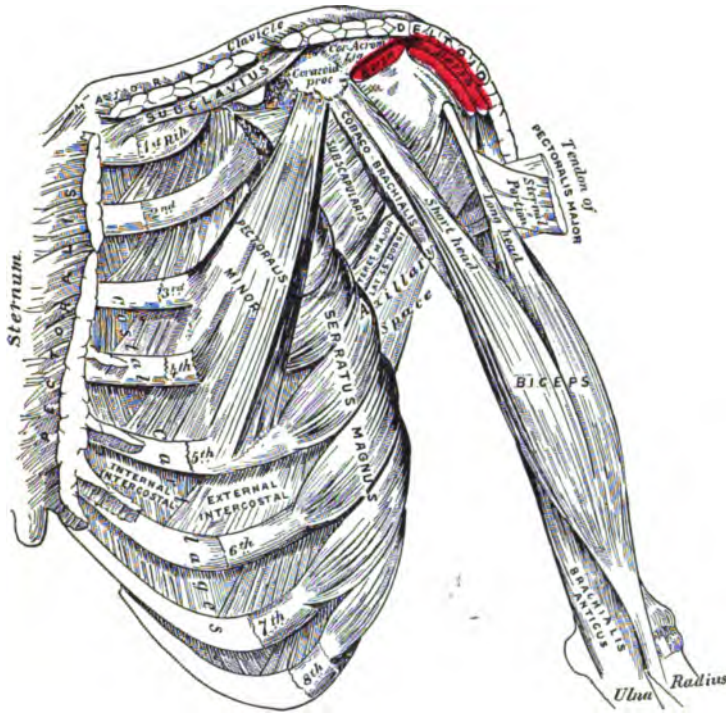


Fig. 91.—Illustrates the anatomical relation of the subdeltoid and subcoracoid bursæ.

plied during the first stage nearly all cases will recover in from one to three weeks. When seen during the second stage the treatment is the same but results are not so flattering. However, the majority of cases in this stage recover in from six to eight weeks.

The third stage may be treated by diathermy, radiant light and heat, vibration and static sparks. I find that these patients bear static currents badly. In cases where the x-ray shows deposits of lime it is worth while to try ionization of chlorin, the technic of which is: Rub vaseline thoroughly into the skin over the point to be treated; apply a pad of gauze 1 inch thick, thoroughly saturated with salt solution, over the part with block tin electrode on top of the gauze pad and attach the electrode to the negative side or pole of a direct current. The indifferent or positive pole is placed over the spine. Use a current strength of 30 milliamperes for thirty or forty minutes, if possible within the toleration of the patient. This treatment is based on the theory that the chlorin will unite with the lime, forming calcium chlorid which is soluble and capable of being absorbed. If this treatment does not succeed in six weeks' time turn the patient over to the surgeon.

Lumps in the trapezius muscle are sometimes the cause of shoulder pain.

Pain emanating from the disturbed organs within the pelvis is varied and complex in character. All sorts of inflammatory exudates, slightly organized and firmly so, forming adhesions of various degree in and about the pelvic contents, are exceedingly common. The uterus in its immediate surroundings is quite well supplied with small ganglia which communicate with the plexes of the sympathetic system. When disturbance occurs in the pelvic contents, the resulting irritation is communicated to the next relay station (plexus); when it becomes exhausted the next is called upon until, one after another, the gastric, duodenal-gastric and hepatic have become exhausted and constipation with all its attending evils becomes apparent; then the cardiac plexus with its attending phenomena and so on to the cord, there reflected to the cranial nerves, pro-

ducing facial neuralgia, and finally to the great psychic center itself it gives way and through its failure to control the physiological impulse we have that complex condition called neurasthenia (Fig. 92).

In case the uterus becomes displaced or its ligamentous attachments become relaxed, or there is an accumulation of

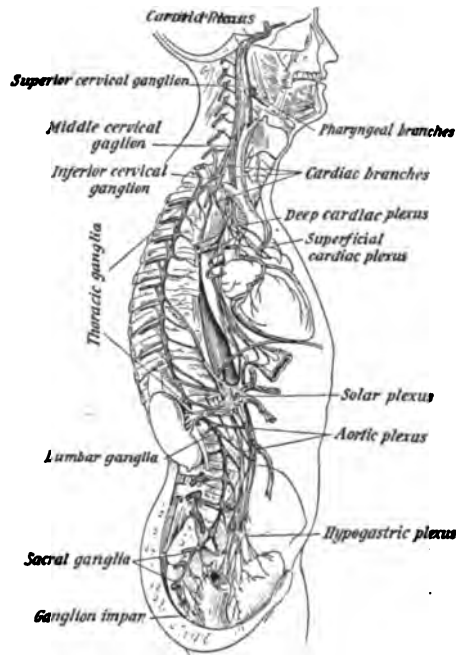


Fig. 92.—The sympathetic nerve system.

pus or various growths about the uterus, pressure may be produced upon the sacral plexus and cause pain at any point of its distribution.

The same train of symptoms may be experienced in the male from disturbance produced in the prostate gland or seminal vesicles, and we have on our hands a sexual neurasthenic.

SCIATICA.

The causes of sciatica are many and varied, but like neuritis elsewhere, it is always caused by pressure from within or without the nerve. Sciatica, like brachial neuritis,

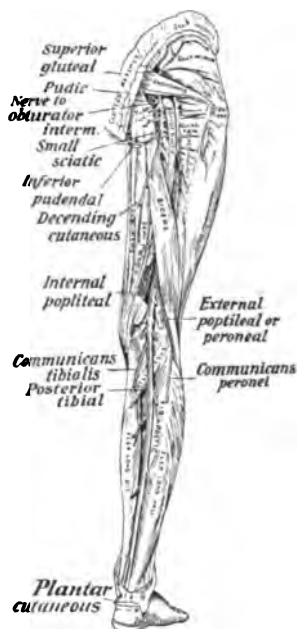


Fig. 93.—Illustrates the relation of the piriform muscle to the greater sciatic nerve.

causes (with but one exception) no limitation of passive motion, whereas arthritis of the hip joint interferes with some movement or other.

The following test will differentiate arthritis from sciatica: With the patient supine upon a level surface, the pelvis perfectly level, the thigh is flexed and then the ankle is placed above the patella of the opposite extended leg. The knee is now depressed; if there be arthritis of the hip

the patient will complain of pain before the knee reaches the level of the opposite knee. This position is easily attained in cases of sciatica.

In case of sciatica, with the knee well flexed, the thigh can be fully flexed without pain; but when, with the thigh

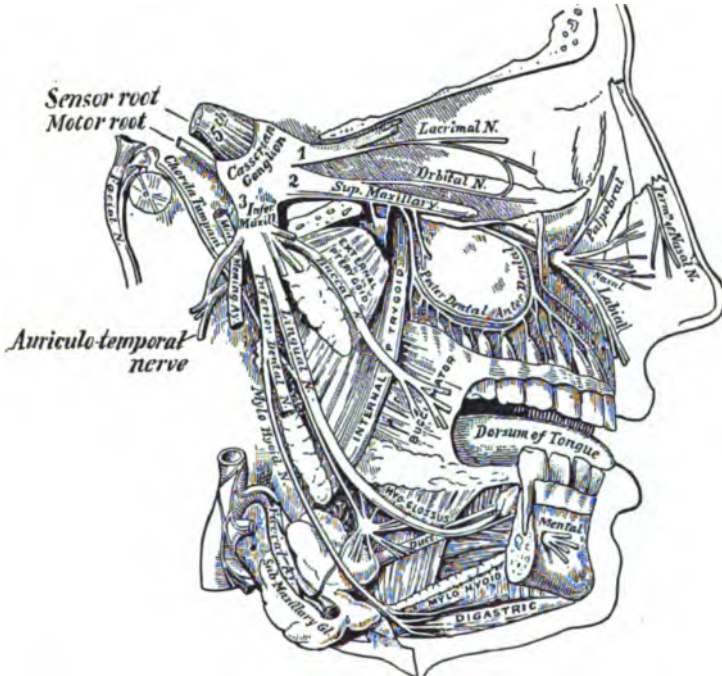


Fig. 94.—Points for testing supra-orbital, inferior orbital and mental nerves.

thus flexed an attempt is made to extend the leg, it cannot go very far without causing pain. This sign is also indicative of sacro-iliac involvement.

Rheumatic lumbar spine and troubles about the sacro-iliac joint are fruitful causes of sciatica. While sciatica is often called rheumatic, I do not believe that it is ever rheumatic except as just mentioned.

The piriform muscle having its origin within the pelvis and passing out through the great sacro-sciatic foramen and attached to the great trochanter is often subjected to pelvic disturbance, causing contraction of the muscle which produces pressure upon the pudic and sciatic nerves, causing pain (Fig. 93).

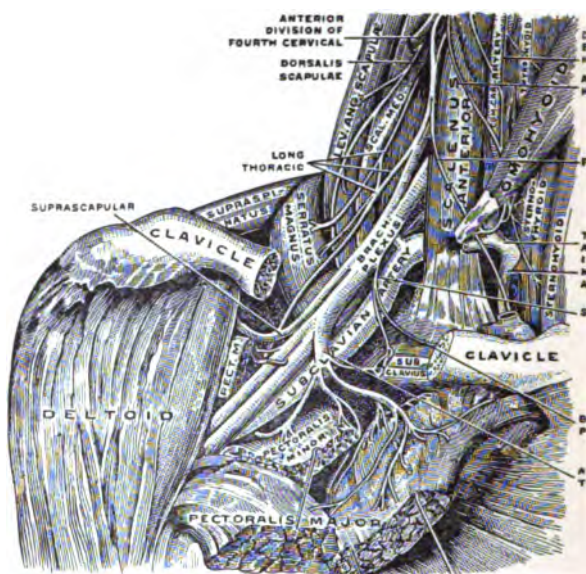


Fig. 95.—Points for testing anterior branch of brachial plexus above or below the clavicle.

In order that success be attained it is absolutely essential that a differential diagnosis be made. It is here that I have found a most valuable assistant in the static wave current. A high-frequency electrode with a high vacuum emitting a white phosphorescence is attached to the positive side of a static machine, with the negative pole grounded and patient insulated; the electrode is passed over the nerve points of the affected region. At the point of pain elicit-

tion the electrode is kept applied for two or three minutes. If the pain is relieved its cause is to be found in muscular pressure; if the pain continues longer than five minutes, or is aggravated, we have a case of neuritis. The points



Fig. 96.—Showing points for testing the posterior branch of brachial plexus.

of application for this differentiation are shown in Figures 94, 95, 96 and 97.

When the electrode is passed along the vertebræ lesions of the spinal nerves may be localized such as intercostal neuritis, herpes zoster and some cases of occupational neuroses. The sacro-iliac and lumbar vertebral causes of sciatica may be located in this manner. I have never tried

the high-frequency current in making these tests, but it may be as useful as the static.

The treatment of some of the causes of shoulder and pelvic pains mentioned is surgical, but the larger number are other than surgical or orthopedic. Treatment directed



Fig. 97.—Illustrating points for testing nerves of anterior portion of lower extremity.

to the digestive function is of prime importance. Examine the urine for albumen which, in some cases, is present; also examine it for sugar and indican as well as urea. The knowledge obtained by this examination will serve as a guide to dietetic and medicinal treatment. A thorough blood examination is advisable for the detection of bacterial poisons. Take the blood-pressure as hypertension may be

the cause of pain and hypotension be connected with nerve exhaustion.

The purely surgical management of these cases I will leave to the surgeon, but I want to say to him: Be sure that other methods of treatment are valueless before you operate. Dr. Bloodgood has most aptly stated: "In the early stages of surgical lesions the diagnosis is the major part of surgery, the operation the minor."

I have seen many cases of shoulder and pelvic pain relieved by a dose of epsom salts. This leads us to believe in autointoxication. Toxemias from special sources, such as nasal sinusitis, pyorrhea, purulent otitis, tonsillitis or any other bacterial focus, require special treatment.

For treatment of neuritis, see Chapter IX.

When a patient comes to us he is usually in a pathological state. What do you try to do for him? Get him into a physiological state by some method, whether it be surgical, medicinal, electrical or psychical. When you use any agent use it physiologically. This is as true of an electrical agent as a medicinal one.

The cause of all censure of electrotherapeutical methods is due either to ignorance on the part of the critic or the misuse and ignorant application of these methods by those who attempt their use.

CHAPTER XII.

RÖNTGENOLOGY.

Diagnosis. Apparatus. Tubes. High and low vacuum tubes. Suggestions to beginners. X-ray dose. Filters. Penetration. Radiometers. Erythema dose. Intensity of treatment. Scale of equivalents. The Grover x-ray dose indicator. X-ray dermatitis. Cancer. Basal cell epithelioma. Carcinoma of the breast. Sarcomas.

DIAGNOSIS.

ALMOST anyone with ordinary intelligence may become an x-ray technician, but in order to become a röntgenologist one must be well equipped in the groundwork of anatomy, physiology and pathology. Seeing a shadow on a plate is easy, but interpreting its meaning calls for a well trained mind in pathology.

No one has yet arrived at that pinnacle of perfection to be always able to determine the cause of the shadow on the plate. What are the tissues which lie between the tube and plate? What is the density of each intervening tissue? If normal, what shadow should appear? If abnormal, what are the probable intervening conditions which cause the shadow?

The clinical history of a case and the laboratory findings are as important to the röntgenologist as to the clinician in arriving at a diagnosis.

The x-ray is the greatest discovery of modern times, but it does not supplant other methods of diagnosis. It is one of the strongest aids, and when it corroborates clinical and laboratory findings it makes a convincing case. The surgeon needs the aid of the internist, chemist, ophthalmol-

ogist, pathologist and röntgenologist. If he needs one more than another, it is the röntgenologist.

The majority of men doing x-ray work today are neither technicians nor röntgenologists. They are at the half-way house arranging the furniture with the hope that it will prove satisfactory to the guests when they arrive. After years of patient toil a physician becomes a röntgenologist, he is the most competent consultant in all branches of medicine and his services are most valuable. Muscular action will make a skiagraph, but it requires brains to interpret it.

APPARATUS.

The first step in röntgenology is an efficient apparatus. The ideal apparatus of today is the interrupterless high tension closed core transformer. The core of the transformer is of rectangular form and composed of laminated iron. The primary winding is placed on one arm and the secondary is placed on the opposite arm. In this form of core there is a minimum of magnetic leakage. The transformation depends upon the ratio of the primary to the secondary turns of wire. If the primary consists of 40 turns of wire and the secondary of 1000 turns, the ratio is 1 to 25, in which case a 220 volt current would be stepped up to 5500 volts.

The efficiency of this type of transformer is much higher than that of a coil. The transformer should be oil immersed. The current coming from the secondary of the transformer is alternating in character, and for efficient x-ray work must be rectified into a unidirectional current, consequently a rectifying device is necessary. Mechanical rectifiers are of two types, the disc and the arm. The disc type is the one almost universally employed.

When an alternating current is furnished from the power station the motor driving the disc is of such design

that it rotates synchronously with the alternations of the current and is, therefore, known as a synchronous motor. Where there is only a direct current available a rotary converter is employed for the purpose of converting the direct current into an alternating one, essential for the operation of a high tension transformer. A synchronous motor is not required in this case because the disc is driven by the rotary converter. While the current from the rectifying disc is not absolutely continuous it is sufficiently so for practical purposes of energizing an x-ray tube. The next step is some scheme for controlling the current. The old forms of variable primary inductances with rheostat control are now being superseded by the auto-transformer control. Where only Coolidge x-ray tubes are used this form of control is all that is necessary, but with gas tubes the rheostat control should be added on account of the variation of the secondary potential.

The advantages of the transformer over the coil are the great amount of current output, permitting the production of quantities of x-ray sufficient for almost instantaneous exposures; the small amount of primary current required; simplicity of control; absence of chemical rectifiers and interrupters and almost fool-proof construction.

TUBES.

A portable apparatus, called a bedside unit, is made possible by a recent discovery of a self rectifying tube called the radiator type Coolidge x-ray tube. It may be operated directly across the terminals of either an induction coil or a high tension transformer. Its capacity is limited, therefore cannot be used for therapy. The anode stem of the Radiator type tube consists of a solid bar of copper $\frac{5}{8}$ inch in diameter, which is brought out through the glass of the anode arm to a copper radiator. This arrangement

gives a greater heat capacity and allows the tube to cool more rapidly between exposures.

The filament of this tube is heated in the same manner as that of the universal type tube, and the tube works equally well on machines delivering a rectified current, in which case it simply takes the place of the universal type. In operating this tube be sure to follow the instructions accompanying each tube as they vary in capacity.

Recently a new type of transformer has made its appearance in Germany. The old type of transformer is limited to an output of 80,000 to 140,000 volts whereas the new type operates with an intensity of from 180,000 to 220,000 volts. The new machine is said to develop hard rays capable of penetrating any part of the body. New tubes have been devised capable of operating with a 16 to 18 inch spark gap and of running constantly for eight to ten hours.

It is unnecessary to go into details of the almost endless variety of x-ray tubes. The manufacturers of machines are able to advise the best type of tube for securing desired results.

For all kinds of work on machines equipped with rectifying devices, the Coolidge tube is the one of choice, but outside of fluoroscopy and therapy, the gas tube has its advantages.

Many methods of cooling tubes have been devised, including water, oil and air. When long continued exposures are required as in fluoroscopy and therapy, the water cooled tube is advisable but has no advantages in ordinary radiographic work.

Methods of raising and lowering the vacuum have given rise to many types of tubes. The so-called self rectifying tube is the one of choice. This form of tube has an accessory chamber which contains mica, carbon and potassium

hydroxide. These are heated by shunting the secondary into the regulating chamber. The accessory chamber is provided with a wire which may be brought into proximity of the cathode end of the tube. When resistance within the tube becomes too high there is a discharge across the gap between the wire and the cathode, thus lowering the vacuum. This regulation is more or less automatic.

The hydrogen tube is so arranged as to permit of the entry of air into the tube at will of the operator. This type of tube is useful in fluoroscopy but not for radiography. The vacuum of an old tube may be reduced by reversing the current and allowing it to pass between the cathode and accessory anode. Many sizes of bulbs are made, but the 7-inch bulb is the one preferred.

The important characteristics of the Coolidge tube as stated by the manufacturers are: (1) No discharge current through the tube unless the filament is heated. (2) The amount of discharge current is determined primarily by the amount of current passed through the filament and hence by the temperature produced. (3) The penetrating power of the x-rays is determined by the voltage across the tube terminals. (4) The starting and running voltages are the same. (5) The allowable energy input is determined by the size of the focal spot. (6) Continuous operation is possible without change of characteristics. (7) The focal spot is fixed in position.

In order to use a Coolidge tube a means of heating the filament must be provided. This may be done by the use of a storage battery or a step-down transformer. The transformer is used where an alternating current is available. The universal type of Coolidge tube should not be used across the terminals of a high tension transformer. While the tube will rectify a certain amount of current the

high tension transformer is liable to overheat the focal spot and destroy the tube.

The penetrating power of x-rays is dependent upon the voltage of the energizing current. The finer the focal spot the less the capacity of the tube. When sharp definition in radiography is desired a fine focus is employed and in therapy the broad focus is used.

The milliamperereading is supposed to show the number of milliamperes passing through the tube. The readings depend upon the degree of vacuum of a gas tube. In a gas tube the greater the vacuum the lower the milliamperage and the harder the tube. The milliamperes passing through a Coolidge tube depend upon the heat of the filament. The greater the heat the more milliamperes will pass, therefore the softer the tube.

The gas tube is a bulb pumped to a certain point approaching a vacuum. It is provided with a means of allowing the ingress of air for the purpose of lowering the degree of vacuum. The nearer a perfect vacuum in a tube the more difficult it is for electrons to pass, hence the necessity for an increase of force or voltage; and when so forced the tube emits more penetrating or hard rays.

The more air in a tube the softer and less penetrating the rays and the less voltage required to operate it. The vacuum of a tube may be roughly estimated by the backup spark. Electricity passes over the route of least resistance. For example: If the current passes through the tube with the spark gap placed at 5 inches we know that the tube has a certain amount of resistance and we say that it has a backup spark of 5 inches. If we desire to employ a vacuum of a certain degree marked by the spark gap in inches we must regulate the tube accordingly. The vacuum of the Coolidge tube always remains the same and the degree of penetration is regulated by the heat of the filament. The

intensity of the rays is in inverse proportion to the square of the distance between the target and the plate. For example: The distance between the target and the plate being 10 inches, the rays will be four times as intense, in the same time, as when placed at 20 inches.

I know of no device which requires as keen a perception to operate successfully as a gas tube. No amount of reading or oral instructions will enable one to operate a gas tube satisfactorily at all times. One must understand his machine and tubes and work out his own technic.

HIGH AND LOW VACUUM TUBES.

Some of the troubles of the beginner in radiography are trying to do work with a tube of too high vacuum, the rays from which are of high degree of penetration with little volume resulting in an image of poor contrast. The part that should be well defined is thin and ill defined and the entire plate assumes a grayish color. Attempting work with a tube of too low vacuum results in an image poorly defined, the denser part of the plate showing a faint outline while the uncovered portion will be black. Overexposure with a high vacuum tube will result in foggy detail. Underexposure with a high vacuum tube will result in no image or one of faint gray color.

With a little practice you will learn to recognize a low, medium and high tube by its appearance. A well defined hemisphere of apple green fluorescence without bluish tinge is of low vacuum; the lighter in color of the green hemisphere the higher the tube until it reaches a yellowish green or almost orange with ill-defined hemisphere when it becomes a high tube. It is possible to have a greenish color fluorescence in a high tube, but it will sputter while the current is leaking off the conductors.

When one has worked out certain settings for operation of a Coolidge tube and has made a record thereof, he may be reasonably sure of duplicating results, but with a gas tube he can only approximate them.



Fig. 98.—Bellevue model röntgen-ray machine. One of the most powerful x-ray apparatus manufactured. It has ample power for the most rapid gastro-intestinal and chest work. It is equipped with rheostat and auto-transformer control. Its maximum spark gap is 12 inches and an output of 250 milliamperes through a tube with a 6-in. back-up. This model fulfills all the requirements for heavy and rapid work.

SUGGESTIONS TO BEGINNERS.

In this short dissertation I believe that a consideration of the pitfalls of the röntgenologist will prove more profitable than a discussion of the laws of röntgenology. We



Fig. 99.—The Victor model "New Universal" x-ray machine is designed for rapid röntgenography, fluoroscopy and therapy. It is equipped with a closed core oil immersed transformer, straight resistance and auto-transformer control and has a maximum spark gap of 10 inches. This machine is properly constructed and capable of doing all kinds of x-ray work.

will now take up a few of the operating troubles of the radiographer:

When a tube is taking little or no current do not increase the voltage as you may damage the transformer.

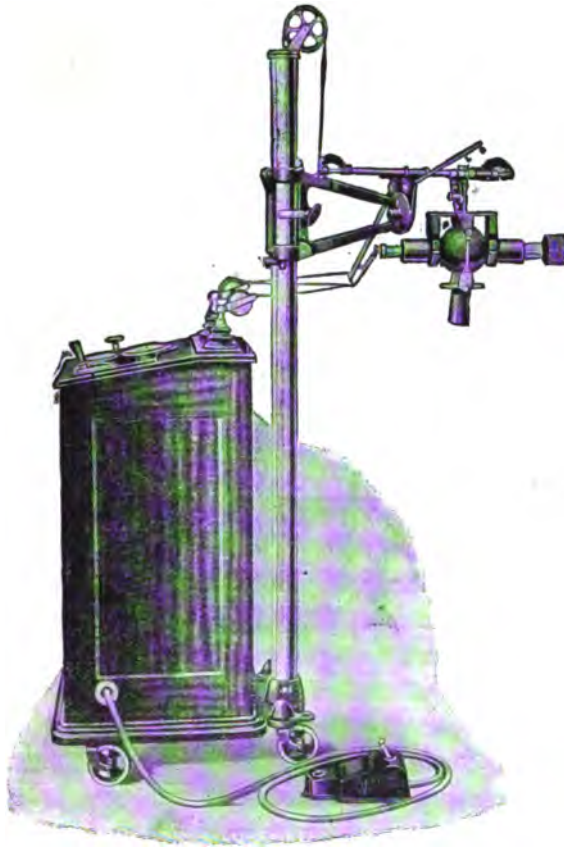


Fig. 100.—Victor portable x-ray unit. Bedside x-ray unit which was so popular in the Base and Field hospitals in the late war. It is designed for general radiographic work and fluoroscopic diagnosis. It has a capacity to energize the 10 ma. or 30 ma. radiator type Coolidge tube and has a penetration equivalent to a 5-in. back-up spark. It is not intended to be used for röntgenotherapy. The portability of this machine makes it desirable for hospital work, as it can be moved from room to room, and examinations made without moving the patient from the bed.

Milliampere and spark-gap readings with gas tubes are not always reliable. The gap shows peak voltage and may be transient. The difference between direct and inverse is indicated on the milammeter and it may read zero and at the same time the tube be sufficiently energized to do radiographic work. Do not allow high tension wires to come close to any grounding material because you will endanger the insulation of the transformer. Do not start the machine on high power. Do not fail to adjust the polarity. Do not fail to keep the motor oiled. Do not fail to keep the transformer coils covered with oil prepared for the purpose. Do not expect a Coolidge tube to make up for your shortcomings. Under proper conditions it will do fine work, but do not allow the target to become too hot.

Fast work conditions are high voltage, heavy amperage, fast plates or intensifying screens and close distance. Clear definition cannot be expected in fast work. If the focal distance be too short the plate will be hazy. Scattering rays tend to produce flat plates. Screens are liable to produce mottled effects.

The tendency toward short exposures seems to lie with all beginners in radiography. Outside of chest and gastrointestinal work we can usually take plenty of time. Better work can be done with a medium focus tube on a 4-inch than a 5-inch spark gap. In following any exposure table for a gas tube one is doomed to make many a failure. Machines vary much the same as individuals and tubes are as freaky and sputtering as a neurasthenic. While work may be duplicated with proper settings of a Coolidge tube, it is practically impossible with a gas tube. For example: One securing a certain result today with a 5-inch gap and 10 milliampere setting with three seconds exposure will tomorrow, with the same settings, secure entirely different results.

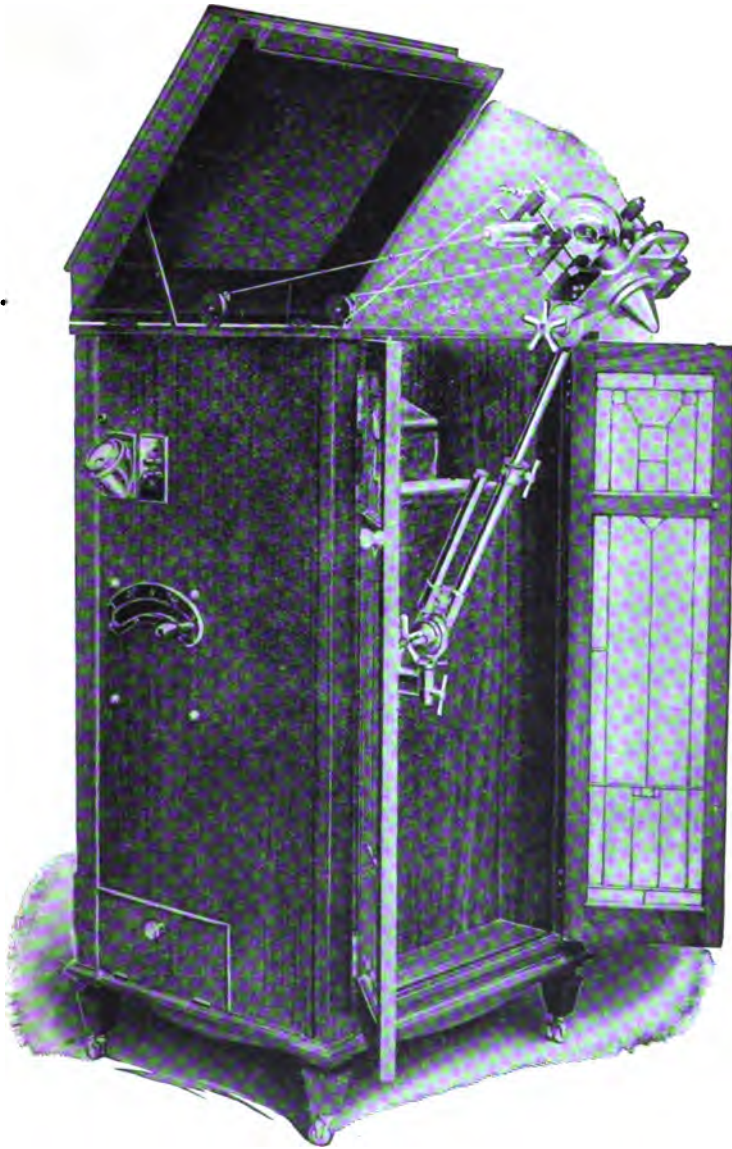


Fig. 101.—The above illustration shows a noiseless, interrupterless transformer type of a machine known as the Thompson-Plaster Co. Model D-1 intended for dental radiography and ordinary bone work. It is not intended for chest and gastrointestinal work. Self rectifying gas tubes only are recommended for use with this machine. The manufacturers make two other machines of similar appearance but of greater capacity, which are known as Model D-2 and Model D-3, designed for use in connection with the radiator type of Coolidge tubes.

In starting out with a new outfit it is advisable for a time to follow the instructions given by the manufacturers as to exposure technic but it will soon become apparent that the operator will have to develop a technic of his own. In bone work a medium soft tube will secure best results. Take all the time necessary with no excuse for haste.

The distance between target and plate in nearly all radiographic work should be 20 inches, but in chest work 28 inches is about the correct distance.

When using an intensifying screen the rays are allowed to pass through the glass to the emulsion, consequently the picture will be reversed. Work done with a screen is inferior to that done without it. If screens are used be sure to keep them clean and dry. The time-shortening factor of the screen varies greatly and the operator should learn his screen as well as tube. As a general rule the screen should be removed from the plate as soon as possible after exposure. Leaving them together for a time will impair rather than improve the plate.

The technic of the dark-room is easily acquired by following explicitly the directions of any good textbook on the subject. Some of the pitfalls of the dark-room are: Trying to use plain sodium hyposulphite; trying to renew a hypo bath by adding new solution; weakening hypo bath by failure to rinse the developing solution from the plate; staining plates with too warm developer; overdevelopment of undertime exposures; transferring hypo to developer with the fingers; a sneaking ray of light in the dark-room; improper shading of ruby light; staining plate with old developer; removing plate from developer or hypo too soon; removing plate from developer to watch the progress of development; improper washing of plates; failure to keep plates properly protected and clear of dust.



Upper molar.



Antrum.



Upper central.



Lower central.



Hip.



Elbow.

Fig. 102.—Model D-1 machine, showing radiographic positions.

If you must use a damp unventilated dark-room, keep your plates elsewhere. Look out for dirty and stained developing trays. Stains may be removed with a solution of sulphuric acid and bichromate of potash and water, but be sure to remove all traces of acid before using again. Trays with broken enamel should be discarded. Do not attempt to use painted trays.

X-RAY DOSE.

The essentials of measurement of x-ray dose are effective voltage, time of exposure, distance between target and skin, and nature and amount of filtration.

In the measurement of x-rays quality and quantity are to be considered. Quality depends upon potential, effects of absorption and length of wave. The speed of electrons passing through a tube depends upon the voltage and the voltage may be accurately measured by a voltmeter connected across the primary of the transformer. In practice the length of spark gap is utilized in estimating the voltage. While this method is not absolutely accurate it so closely approximates accuracy as to be of practical use. The length of the spark between the terminals depends somewhat upon the diameter of the discharging points; needle points will allow a longer spark than blunt ones. It requires a potential of about 55,000 volts to cross a gap of 4 inches and an increase of practically 10,000 volts to each inch increase of gap. Many devices have been constructed for the purpose of measuring the penetrating quality of x-rays all of which are based upon the selective absorption by metals of rays of varying penetrability. The Benoist penetrometer is probably the one most in use; it consists of a silver disc surrounded by 12 sectors of aluminum, varying in thickness from 1 to 12 mm. The hardness of the rays being

estimated by a comparison of the shadow of the silver disc against the aluminum.

The Christen method of measuring the quality or penetrating power of x-rays is a fluoroscopic one and is based on the absorption of the varying thicknesses of water or bakelite. An amount of water or bakelite which absorbs 50 per cent. of the rays is adopted as the standard.

The Christen meter consists of a plate of lead 1 centimeter square and is so perforated that the area of all the holes is equal to the area of lead between them. This perforated lead plate is placed in an opening in a sheet of lead adjoining a small window. Over this window there moves a stepped wedge of bakelite. A fluorescent screen is placed so as to cover both window and perforated plate. The perforated plate is at such distance from the screen that the circles of fluorescence merge and the screen is evenly illuminated by a ray which has been half absorbed. (Hirsch.)

Christen states that if one desires as great an amount of energy at a certain depth as possible such ray should be used whose semireducing unit is equal to the thickness of the layer beneath the surface it is desired to effect.

Comparing the Christen with the Benoist method, 1 centimeter of semireducing layer equals about 5 B. and 2 centimeters of semireducing layer equals about 9 B.

Pure water absorbs practically the same amount of x-rays as the soft tissues of the human body. Lung and fat are more and bone less penetrable than water. The intensity of the rays from a medium tube diminishes rapidly as they pass into the tissues; 50 per cent. of the rays penetrate only the first $\frac{1}{4}$ inch and only about 20 per cent. ever arrive at the depth of 1 inch.

When it becomes necessary to reach the deeper tissues a harder ray must be employed and as this increases the intensity on the skin some absorptive material must be in-

terposed to prevent a dermatitis. Aluminum of varying thicknesses is usually employed.

FILTERS.

Various substances have been employed to filter or screen out soft rays; such as tinfoil, sole-leather, aluminum, etc. A single layer of tinfoil of which 100 square inches weigh an ounce or an ordinary thickness of sole-leather will absorb about the same quantity of x-rays as 1 inch of flesh and the soft rays from a medium tube are nearly all absorbed by such a screen. While tinfoil was extensively used a few years ago, it has been almost superseded in recent years by aluminum. Sole-leather is still used by many operators. Copper and zinc are used as filter material in connection with the lately constructed powerful high tension transformer and induction apparatus.

PENETRATION.

X-rays consist of many different wave lengths and these have different degrees of penetration; short rays are more penetrating than long ones. Different substances present more or less resistance to passage of x-rays and the absorption is closely related to the atomic weight of the substance. The greater the atomic weight the greater the absorption. The harder the ray the shorter its wave length. The length of the wave or the degree of hardness of the ray may be estimated by the voltage or back-up spark.

For practical purposes, it may be stated that a voltage sufficient to back up a spark from 1 to 4 inches will produce soft rays, 4 to 7 inches medium rays and above 7 inches hard rays, but it must not be forgotten that the highest voltages produce both long and short rays, in other words a 9-inch spark gap, while it produces highly penetrating rays it also produces an increase of soft rays.

MEASUREMENT OF QUANTITY.

In considering measurement of quantity or intensity of x-rays not only voltage, amperage and time, but absorption at various depths becomes a factor.

It is well known that under the x-ray the iodine in a solution of iodoform in chloroform is liberated in quantities in proportion to the intensity of the rays and the intensity of the color compared with a standard will indicate the dose applied. (Freund.)

The x-ray will also precipitate calomel from a mixture of bichlorid of mercury and oxalate of ammonium and the dose may be estimated by the thickness of the deposit. (Schwarz.) There are many other chemicals that will change color under x-rays, and advantage has been taken of this in measurements of quantity of x-rays by different individuals.

RADIOMETERS.

The Holz knecht chromoradiometer consists of a chemically prepared pastile and when exposed at $\frac{1}{2}$ target skin distance changes color in proportion to the intensity of the rays. A color scale is employed and numbered 1, 2, 3, 4, 5. These numbers indicate the dose corresponding to the number of Holz knecht units; number 5 of this scale indicates the quantity of rays sufficient to produce an erythema or skin dose.

The Sabouraud & Noire radiometer consists of a tablet coated with barium platino-cyanide which is exposed at $\frac{1}{2}$ target skin distance during the x-ray application. When the original apple green color has changed to a brownish yellow corresponding to tint B an erythema dose has been applied.

The Hampson radiometer consists of a graduated color scale of 25 tints. The exposed pastile is compared with

the color scale. No. 16 is equivalent to tint B of Sabouraud and 5 H at $\frac{1}{2}$ target-skin-distance or $1\frac{1}{4}$ H with pastile on the skin.

The Kienbock method consists of a strip of silver bromide paper exposed to the ray and when developed by a stated developer at a certain temperature for one minute the dose is determined by the degree of blackening compared with a standard scale. The scale is composed of strips of paper of various degrees of blackness and numbered 1x to 10x. Unless every detail is carefully carried out the result is likely to be unsatisfactory.

A new iontoquantimeter has been devised by Szillard for the determination of dosage, which is to be used in connection with the German high tension transformer. It is said that with the aid of this new meter and with proper filtration and target-skin-distance, an exact dosage may be delivered at any point of the body.

Radiometers in general differ but little in principle, but trying to carry the many methods in mind is confusing. The adoption of any one of them is all that is necessary for one's own use, but in order to read x-ray literature intelligently one must become acquainted with all of them. One writer may give dose in Holzknecht units $\frac{1}{2}$ target-skin-distance, another H units pastile on the skin; another Hampson units; another Kienbock units; another the tint of Sabouraud and still another in milliamperes minutes.

ERYTHEMA DOSE.

The erythema dose generally accepted as standard is equivalent to 5 H, 10X, 16 Ha or $7\frac{1}{2}$ M.A.M. with a 6-inch gap at 8-inch target skin distance, unfiltered. However, many operators have worked out to their own satisfaction a skin dose which in most instances far exceeds the standard. The standard dose is always safe even upon the skin of

the face of a young blonde. There are many patients who can tolerate two or three times a standard dose. No operator is justified in exceeding the standard dose until the toleration of his patient to the rays is thoroughly understood.

In the treatment of epitheliomas, I have employed doses equal to 6 times the standard unfiltered dose. They were cases of old men and where I expected a second degree burn, but many times only a slight erythema was produced. A long experience is required to attain the knowledge of how to secure the proper degree of penetration without producing a burn.

With all the methods devised for reading a skin dose we are still unable to know exactly the quantity applied. The M.A.M. method is as satisfactory as any other and more easily applied.

The intensity of unfiltered x-rays upon the skin varies inversely as the square of the distance. If the distance be reduced one-half the effects are quadrupled. Reducing the target-skin-distance $\frac{1}{2}$, only doubles the dose of filtered rays. The other essentials, voltage, amperage and time vary the intensity in direct proportion. In other words doubling either spark gap (voltage), amperage or time doubles the dose. In computing the intensity of x-rays upon the skin a spark gap of less than 3 inches should not be considered because the voltage is too low to produce an accurately measured dose. It is well known among radiographers that doubling the voltage quadruples the intensity upon a photographic plate, but this is not true in a biological sense as doubling the voltage only doubles the intensity upon the skin. Radiographic effects are of a chemical, and radiotherapeutic effects of a physiological nature.

It is well known that a skin which has been recently treated by such drugs as iodine, mercury, chrysarobin and

carbolic acid is very sensitive to x-rays. In case it becomes necessary to ray a skin which has been treated by drugs the dose should be reduced one-half and then one may be surprised by the appearance of a dermatitis. Such drugs as just mentioned applied to the skin after the administration of x-rays will produce the same effects as if applied before.

No hard and fast rule can be applied to all cases. The skin of a blonde is more sensitive than that of a brunette. The older the person the greater toleration and less liability to burns. Flexor surfaces are more sensitive than other surfaces. The face is most and the scalp the least sensitive of all.

While exercising care for the patient do not forget to amply protect yourself. Lead glass is the usual form of protection used and this should have an absorption equal to $\frac{1}{32}$ inch of lead. Avoid all direct rays in using any form of fluoroscope. The various devices for protection may be easily tested by attaching a few dental films to the clothing while operating. If this procedure shows lack of protection, make changes requisite for safety.

INTENSITY OF TREATMENT.

Intensity of treatment is divided into three degrees, *viz.*: Intensive, semi-intensive, and fractional.

Intensive treatment is equal to a single exposure to one area at monthly intervals of a quantity ranging from 1 H to 2 H units unfiltered or 2 to 3 H filtered. This is equivalent to 6 to 12 M.A.M. with a 6-inch gap at 8-inch target-skin-distance unfiltered or 12 to 24 M.A.M. filtered.

Semi-intensive treatment; $\frac{1}{2}$ to $\frac{3}{4}$ H unfiltered or 1 H filtered at intervals of two weeks which is equivalent to 3 to $4\frac{1}{2}$ M.A.M.

Fractional treatment; $\frac{1}{8}$ to $\frac{1}{4}$ H unfiltered or $\frac{1}{4}$ to $\frac{1}{2}$ H filtered at intervals of three or four days. This is

equivalent to $\frac{3}{4}$ to $1\frac{1}{2}$ M.A.M. unfiltered or $1\frac{1}{2}$ to 3 M.A.M. filtered with a 6-inch gap and 8-inch target-skin-distance.

The terms Holz knecht unit and the skin unit of Holz knecht are confusing. Five H units estimated with pastile $\frac{1}{2}$ target-skin-distance equals $1\frac{1}{4}$ H with pastile on the skin.

Writers are not always careful to state which method is employed.

SCALE EQUIVALENTS.

Erythema Dose.

5 Holz knecht	One-half target-skin-distance.
$1\frac{1}{4}$ H.	Pastile on the skin.
10 X. Kienbock	Strip on the skin.
16 Ha. Hampson	Pastile one-half target-skin-distance.
4 Ha.	Pastile on the skin.
Tint B. Sabouraud	One-half target-skin-distance.

Skin Dose.—Erythema dose, skin dose, skin unit and epilating dose are synonymous terms and mean a quantity that will provoke an erythema on most parts of the skin or epilate scalp hair.

There is no hard and fast rule that applies to all röntgen apparatus in grading dosage. My advice is to adopt a certain skin distance and a certain spark gap for all cases of röntgen therapy, the variations of dose to be determined by the time of application.

The author has devised an indicator for the purpose of translating the various methods of measuring an x-ray dose (Fig. 103). It consists of 4 discs which may be so arranged, not only to translate Holz knecht (H), Kienbock (X) or Hampson (Ha.) units into milliamperere minutes (M.A.M.) but to indicate the proper setting of the machine to secure any dose desired. The directions for its use are printed on the back of the large disc and are as follows: set the discs (milliamperes, spark gap and minutes) so

that the product of the three numbers in line (one number on each disc) shall equal some one number on the fourth or large disc. Place all four in line when dose, spark-gap minutes and milliamperes are indicated.

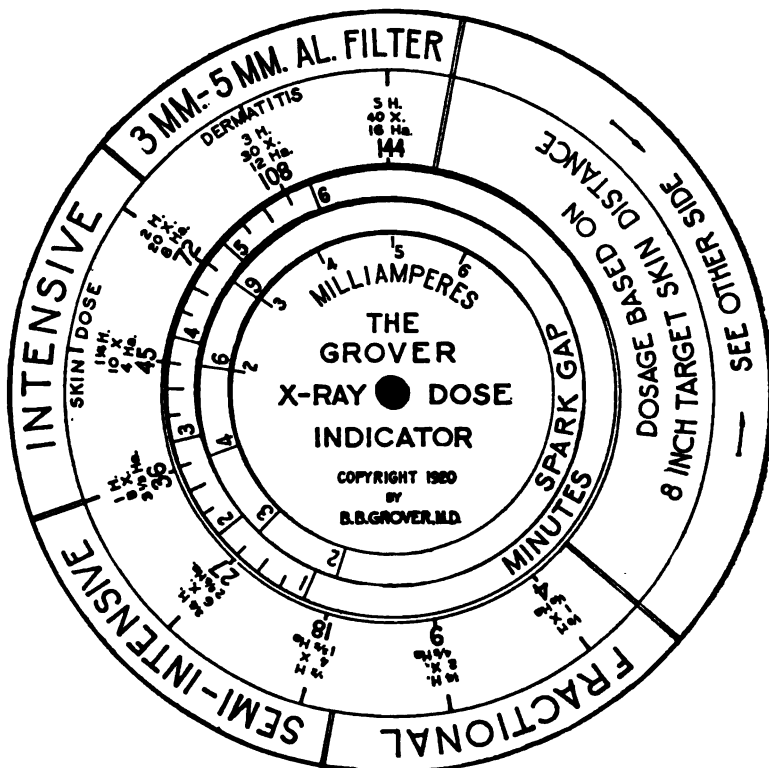


Fig. 103.—The Grover x-ray dose indicator. The proper setting for the administration of a skin dose: Spark gap 6, ma. 2, minutes $3\frac{3}{4}$ = 45.

Example.—Turn No. 2 on the milliamperage disc to No. 6 on the spark-gap disc; turn both together to No. 3 on the minute disc. The product of the three numbers in line is 36 ($2 \times 6 \times 3 = 36$) by turning all three discs already set to

36 on the fourth disc, the dose is indicated. Suppose a 9-inch spark gap is required for deep penetration and an intensive treatment of 5 H desired. Under 5 H will be found the number 144. Set No. 9 on the spark gap disc to 144, divide 144 by nine ($144 \div 9 = 16$) which equals 16 the number of milliamperes minutes. Any number of milliamperes times minutes which equals 16 is the proper setting of the machine ($4 \text{ milliamperes} \times 4 \text{ minutes} \times 9 \text{ spark gap} = 144$). Any other setting may be found in the same manner.

Whenever necessary to employ a spark gap of 8 to 10 inches to secure sufficient penetration, a filter of 3 or 4 mm. of aluminum should be used. In the majority of cases the best results are secured by a spark gap of 5 to 7 inches without a filter.

X-RAY DERMATITIS.

Dermatitis produced by x-ray is divided into degrees as follows: *First degree*—a simple erythema. *Second degree*—erythema followed by exfoliation, vesiculation and severe pain. *Third degree*—the skin and subcutaneous tissues and sometimes the muscles are destroyed. It is accompanied with excruciating pain and requires months or years to heal. *Sequelæ*: loss of hair, pigmentation, telangiectasis, atrophy, keratoses and sometimes an ulceration that never heals.

Treatment of X-ray Burns.—Radiant light and heat and the following recipe are useful in first and second degree burns.

R	Zinci oxidi	3ij.
	Acidi carbolic	gr. xv.
	Glycerin	3ss.
	Aquæ calcis q. s. ft.	3iv.

M. et Sig.: Shake the bottle. Apply every three hours and leave exposed to the air.

The management of third degree burns is surgical.

The greatest influence of x-ray is exerted upon new cells and those physiologically active. The glandular structure of the testes and ovaries is influenced promptly and profoundly, hence the necessity of protecting these organs in all x-ray exposures. It is quite probable that the effects produced on these structures are the result of scattered beta and gamma rays. If this be true the action is one of ionization. We have learned by experience that small doses of x-ray administered at long intervals stimulate newly formed cells and that large doses destroy those present and inhibit the formation of new ones.

The x-ray as a therapeutic measure has a wide field of usefulness recognized in its ability to produce effects from the mildest stimulation to absolute destruction of cell life. The radiographic feature of the x-ray is growing rapidly, while the therapeutic feature is growing slowly. This is but natural since the therapeutic properties are more difficult to understand. The physiological action of the rays themselves, as well as the effects of the scattered beta and gamma rays upon the different tissues of the body, is not well understood.

Early experiments with x-rays have proven some of their deleterious effects and developed a caution in their employment in therapy. We have learned the lesson of procedure with the soft pedal. A number of enthusiastic röntgenologists have applied the rays for almost all diseases known to man, and were their statements to be taken without qualification we would hardly need any other therapeutic agent. Then there are others who have ideas of their almost utter uselessness in medicine. Between the two extremes will be found the silent painstaking investigator who has not as yet made a full report of the results of his study.

CANCER.

Epitheliomata.—Many methods of treatment, among which are surgery, radium, acid nitrate of mercury, caustic pastes such as arsenic, chlorid of zinc, etc., carbon dioxide snow, actual cautery, desiccation, electro-coagulation, zinc ionization and solutions of eosin have been employed in the management of epitheliomas, all of which methods have been proven more or less successful. It is my experience that plaques and superficial cases in general, whether on the skin or mucous surfaces, are best managed by desiccation according to the Clark method.

Before the days of x-ray and high-frequency currents it was common practice to treat these cases with caustic pastes, the results being quite as good as by modern methods excepting the higher percentage of relapses. The use of eosin in these cases, as far as I am advised, was first suggested by Abrams. My experience with eosin is limited to three cases during the past year. In two of these cases the only effect was to stop the growth. These were afterward removed by röntgenotherapy. The other case was an epithelioma on the lower lip involving the mucous surface only. He received no treatment except the daily application of a 10 per cent. solution of eosin. The result was that its extension was under control within two weeks and in six months the growth had entirely disappeared.

The advantages of the x-ray over other methods of treatment are easy technic; painless application requiring neither local nor general anesthesia; no shock and usually but one intensive treatment required. When the growth has been excised it is best to employ the x-ray after the operation to effectively destroy the proliferated cells that may have escaped the knife.

The adjuncts to röntgenotherapy in the treatment of malignant disease are surgery and electrocoagulation. In

malignant disease about the face a thorough treatment by electrocoagulation followed by röntgenotherapy is, to my mind, the best procedure.

Basal cell epithelioma presents the following types: plaques, nodular, superficial ulcer, deep ulcer and their combinations.

Results of Treatment in Different Types.—The superficial ulcer form is the one most amenable to x-ray; the next in order is the nodular form; next, the ulcerated nodular, while the most rebellious is the deep indurated ulcer form. In superficial plaques 100 per cent. results are expected.

Degree of Reaction.—The observations of most röntgenologists, and confirmed by myself, are that while we get a second degree reaction from one treatment we obtain the largest percentage of cures and the least number of them when there is *no* reaction.

Age.—There is but little difference in results depending upon the age of the patient. My experience shows the older the patient the less liability to reaction.

Sex.—If there is any difference in results of treatment between male and female it is in favor of the female.

Epitheliomas involving both skin and mucous surfaces do not yield readily to röntgenotherapy. Electrocoagulation is a better method of treatment.

Quality of Ray.—The consensus of opinion of röntgenologists is that a medium hard tube gives best results. Lesions that are very much indurated or deeply seated are rayed through a filter of 3 mm. of aluminum, but better results obtain in superficial lesions without the filter. There are fewer relapses from unfiltered than from filtered rays.

Relapses.—The greatest number of relapses occur during the first year but relapses occurring after five years have been recorded. However there is little likelihood of a relapse after the third year. Approximately 98 per cent. of

relapses yield to a second course of treatment, leaving unbenefited about 2 per cent. About one-third of the cases is cured by one intensive treatment, one-half by two treatments and one-eighth by three treatments. A few cases require as many as six or seven intensive treatments.

CARCINOMA OF THE BREAST.

Röntgenotherapy is a recognized treatment of cancer of the breast in postoperative, recurrent, primary inoperable and metastatic cases. As a postoperative treatment it will prevent a recurrence in possibly one-third of the cases. In all others mentioned the effects are only palliative.

Technic.—In postoperative cases the crossfire method is the one of choice. The chest is treated anteriorly, posteriorly and latterly with full filtered doses. The axilla and the lymphatics of the breast on the affected side are given three or four doses. The supraclavicular, subscapular and suprascapular regions should each receive one full dose. The mediastinum should also be crossfired. A few treatments over the liver may prevent metastasis. The production of third degree dermatitis in cancer of the breast is sometimes justifiable. From five to seven erythema doses are required to kill cancer cells.

Drs. E. G. Beck and Paul Eisen of the North Chicago Hospital, in November, 1918 number of the American Journal of Röntgenology, describe a new method of procedure in recurrent carcinomas. Dr. Beck says: "I recommend the removal of all tissues, skin, fat, muscle and as much of the tumor as feasible, leaving the cancer bed widely exposed in order that the rays may penetrate directly into the seat of the malignant growth."

In treating cases of cancer where the skin has been removed the technic is somewhat modified. There is no skin to become inflamed, hence the ordinary method of reading

dose is eliminated—there being nothing left but the appearance of the tissues and the general systemic effects from which to judge the dose. Ten or even twenty skin units may be administered daily for five days. The dose depends upon the depth of the cancer tissue and the toleration of the patient. High voltage and low amperage are employed. The tissues being bombarded by heavy dosage become rapidly necrosed. In a few days the destroyed cells slough, leaving the tissues to return to their natural color with intervening areas of cancer still colored which finally slough, when, if necessary, the treatments are resumed. Signs of toxemia, such as sleeplessness, loss of appetite and general weakness should be looked for, and if present the treatment for a time be suspended. The skin about the open wound should be thoroughly protected from scattered rays.

In connection with the new German transformers (180,000 to 220,000 volts) a new technic has been adopted in the treatment of cancer and myomata.

At Bumm's clinic in Berlin, cancer of the uterus is radiated from four points of entry, front, back, right and left sides. Each field being exposed for a period of ninety minutes or six hours in all. A target-skin-distance of 10 inches and a filter of 0.8 mm. of copper are employed. With a pressure of 200,000 volts and 16 inch spark gap it requires one and one-half hours to obtain an erythema dose at the depth of 4 inches.

For cancer of the breast an entirely new technic has been adopted. A target-skin-distance of 28 to 36 inches with a filter of 0.8 mm. of copper are used. With 28 inch distance, five hours are necessary to obtain an erythema dose. With this setting it is claimed that 85 per cent. of an erythema dose penetrates 3 to 5 cm. under the surface of the skin. Four points of entry are used, one over the breast, one over the back, one in the axilla and one over the supraclavicular

region. Each field is radiated for two hours or a total of eight hours at one sitting.

Fibroids are exposed for forty minutes from front and back, eighty minutes in all.

X-ray methods of treating cancer are in the experimental stage, consequently the data available is insufficient from which to draw definite conclusions; but it seems safe to predict that the x-ray will take its place along with other recognized methods of procedure in röntgenotherapy.

SARCOMATA.

The success of röntgenotherapy in sarcomata depends largely upon the histological structure of the tumor. Round and spindle cell sarcomata have shown favorable results. Polymorphous cell sarcomata do badly, still the treatment is worthy of a trial. Melanosarcomata of recent growth are influenced favorably. All sarcomata require intensive treatment.



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